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FACTORIES

ANNUAL REPORT OF THE CHIEF INSPECTOR OF FACTORIES

FOR THE YEAR

1955

Presented by the Minister of Labour and National Service to Parliament
by Command of Her Majesty
November, 1956

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ANNUAL REPORT

Introduction

To the Right Honourable IAIN MACLEOD, M.P., Minister of Labour and National Service.

Sir,

I have the honour to present the Annual Report on the work of the Factory Department for the year 1955.

The ever-increasing industrial activity had its effect in various ways on the work of the Inspectorate; since 1954, the factory population increased by 2·5 per cent, the number of factories with power by 0·4 per cent, and the number of accidents in factories (though not the accident rate) by 1·2 per cent. The accident rate in factories has, with the exception of a slight increase in 1953, decreased every year since the war, including the year under review, and in 1955 the rate was the lowest yet recorded.

One indication of the increasing industrial activity during the year was the increase in the number of orders and permissions in force under the Employment of Women and Young Persons Act, 1936, the Defence (General) Regulations, 1939, and the Factories (Evening Employment) Order, 1950, allowing hours of employment for women and young persons outside or in excess of those permitted by the Factories Act, 1937. There was also a certain amount of illegal employment, notably of children of compulsory school age during the holidays.

Two codes of Regulations came into force during the year. The Employment of Young Persons (Glass Containers) Regulations, 1955, came into operation in March. These Regulations enable young persons aged 16 and over to be employed on shifts between midnight and 6 a.m. in consecutive weeks in factories in which glass containers are manufactured by automatic or semi-automatic machines, provided they are not employed during those hours on more than 12 days in any period of 28 consecutive days. The other code was the Indiarubber Regulations, 1955, which prohibit the use of carbon bisulphide in the cold-cure process of vulcanising in the proofing of cloth with rubber. This code and the Indiarubber Regulations, 1922, are dealt with in Chapter 19 of this Report.

The outstanding event of the year was the inception, on the advice of the Industrial Health Advisory Committee, of two surveys, one to review conditions affecting health in all factories in a single locality, Halifax being chosen for the purpose, and the other to survey a single industry, that selected being pottery. Work on these two surveys is still in progress at the time of going to press; it is therefore only possible at present to recognize the willing co-operation received from all concerned, which is evidence of the lively interest in industrial health that prevails throughout the country. In view of this I have commented in this Report at greater length than usual on one aspect of industrial health, namely factory medical and nursing services.

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While there is no spectacular item to report in the field of safety, methods of guarding are being steadily improved to a degree which augurs well for a substantial reduction in machinery accidents if the improved methods can be sufficiently widely applied.

Mechanization and automatic control of factory processes of all kinds is becoming more and more widespread, but the cumulative effect on production and on working conditions of a number of such changes in relatively small items is probably much greater than that of the more obviously impressive examples of full automation in the larger plants. Whatever the plant or the degree of automatic control, it is always important to ensure that control mechanisms have the characteristics necessary for safety, and this can best be done in the initial stages of design. The Factory Department is willing to give advice in this as in other fields.

A special study has been made of the accidents occurring during the year at abrasive wheels, and the results were used as the basis of a draft code of Special Regulations which has since been issued as a statutory draft in accordance with the procedure laid down.

I have reported at some length on the Iron and Steel Foundries Regulations, 1953, the report reviewing the progress made since the Regulations came into force. It is evident that a great deal of work has been done by all concerned to achieve the considerable progress which is reported from all parts of the country.

During the year, a very extensive programme of reorganization and redecoration at the Safety, Health and Welfare Museum was completed and, at a ceremony attended by the Minister and many representatives from industry, professional bodies and Government Departments, the Museum was renamed "The Industrial Health and Safety Centre".

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INDUSTRIAL DEVELOPMENTS

Design of Factory Premises

Where space is available, as in trading estates and in the new towns, design of factory premises continues on the lines mentioned in last year's Report. The new factories are generally single-storey buildings constructed to give both the maximum headroom and large floor areas unobstructed by pillars or columns. Unless the fire risk is negligible, considerations of fire-prevention arise in this kind of design. In some areas, notably the County of London, local Building Acts can require either division walls or other proper arrangements for lessening danger of fire in buildings of a cubical extent exceeding a specified figure.

As an example of the speed with which factory buildings can be erected by using modern techniques, an Inspector reports that the plans of a 28,800 sq. ft. single-storey building of steel frame construction were passed to the contractors in April and the building was occupied in October. The stanchions are made of two channels welded together to form a square tube which presents a neater line and reduces the amount of concrete required to cover them in comparison with that required to cover rolled steel joists of "I" section. The walls of the main workshops are constructed of a patent aluminium panelling, while those of certain smaller rooms are of brick; large areas of patent glazing ensure good natural light, and additional natural lighting is provided by monitor-type roof lights. The roof is covered with patent aluminium panels, insulated on the outside with fibre-board covered with asphalt. The flooring is of strip wood on joists and concrete.

In contrast to the prevailing light structures, some new factories were solidly built of concrete bricks and tiles; the exterior of one food factory was made more cheerful by the plentiful use of coloured tiles. Instances were also reported of the replacement of some buildings constructed of light sheeting, which had not been insulated against heat loss, by brick construction.

In congested urban areas, progress was made during the year in the erection of modern flatted buildings in which to rehouse small firms occupying old and unsuitable premises. One such building in the London area is described as follows. The four-storey building is of fireproof construction throughout, with wood-block floors laid on concrete. Each floor has a central dividing wall with large sliding fireproof door, so that the floor can be let off into two separate factories if desired. An inside central staircase gives access to each side of the building and there are two outside staircases, one at each end of the building. Two electric lifts, again one at each end of the building, serve all floors. Provision is made for the storage of inflammable materials on the roof. At each end of each floor sufficient sanitary and washing accommodation has been provided for the maximum number of persons who can legally be employed in accordance with the section of the Act framed to prevent overcrowding, in this case 150 on each half-floor. Excellent window-area has been provided and the building is centrally heated.

Some Inspectors consider that self-contained provision as described above is preferable to shared facilities, because the communal provision of washing facilities, etc., requires very strict arrangements for maintenance and much goodwill on the part of everyone concerned if it is to be successful. Instances are, however, quoted in which communal facilities, including canteens, are being used in a manner satisfactory to all.

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The Midland Regional Board for Industry have during the year interested themselves in factory design. They realized that the tendency of recent years to build single-storey factories was fast producing in the Midlands a state of affairs where there would be no room for further industrial development. This was being intensified by the big programme of slum-factory clearance scheduled for the next few years. The Board were anxious to learn something of the relative constructional and operating costs of single-storey as compared with multi-storey factories and were surprised to find that there was little information available. Accordingly, they have sponsored some research into the relative costs and merits of various types of factory premises. The research will be concerned with the methods and costs of construction, and the effect of the different types of factories on production. The necessary finance is being subscribed by various firms and professional organizations, and the research work is to be carried out by the Building Research Station of the Department of Scientific and Industrial Research over a period of two years. It is hoped that some standardization of a few definite types of factory buildings will result, for which there will be adequate data as to building materials, heating, lighting, ventilation, welfare facilities and, not least important, costs.

Methods of Production

During the year, throughout the whole country and in factories of all sizes and types, there were many examples of improvements in methods of production, of increasing mechanization and of varying degrees of automation, all of which were designed to increase output.

Apart from large-scale alterations of plant and changes in methods, an example may be given of the kind of development that is going on. The manipulation and processing of sheepskin in a factory employing less than twenty persons is not the kind of undertaking that seems at first sight to afford much scope for mechanization. Yet, in this small works, a travelling drying oven, served by conveyors and oil-fired, has been introduced to dry the fleece, which had hitherto been laboriously spread by hand over the open hearth of a hand-stoked, coke-fired drying oven. There is nothing new in the use of travelling ovens and this minor development, although it eliminated a good deal of unpleasant toil in the small works, would not be worthy of mention were it not that in any District, in any of the last few years, the effect of this small development could easily be matched by a hundred small developments of a similar kind in every type of factory. The cumulative effect of all these small moves in mechanization has been to bring about a transformation in the industrial scene, and it is a transformation that is still in progress.

The layout of new plant has greatly improved, and it is generally realized that wide gangways, which permit the use of internal mechanized transport, are a great help to production. The greater output of modern plant reduces the number of individual machines required and offsets the floorspace taken up by the provision of the wide gangways. An Inspector describes "flow units" in the manufacture of collapsible tubes, whereby metallic slugs, from which the tubes are formed, are fed into the presses and so to the screwing, enamelling and printing machines and stoving ovens without being touched by the operator, who merely has to remove them on completion. To assist flow and the transportation of work and materials, the units have been laid out with presses at the extreme ends of the building, so that the work flows in towards the centre. Packed work is placed on pallets, situated on either side of the central gangway, for transport by fork-lift trucks. This layout and

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mechanization has resulted in a 50 per cent reduction in transportation. In this building, all services are carried in the roof and so arranged that they can be tapped at any point.

Changes in methods of production and alterations in factory layout usually result in improved working conditions. At a chemical works, for instance, conditions of work have been greatly improved as the result of the installation of a Kachkaroff sulphuric acid plant. The gas passes from the rotary burners to the reaction towers, coolers, and denitration tower. The acid is then conveyed to the concentrating chambers, filters and storage tanks from which it is drawn off for dispatch in tank wagons. The whole process, which is continuous, is handled by remote control.

Another example of increased production coupled with improved health conditions is that of a tar macadam plant which is electronically controlled. By setting dials on a control panel the amount of tar, stone, grit and type of stone may be determined and controlled. One man is in charge of this plant, which produces about 450 tons of tar macadam per day as against 150 tons per day at the old plant where two operators were employed. In the old plant there was a great deal of tar on the walkways and fittings and no one could approach this part of the plant unless wearing protective clothing. The operator at the new plant wears white overalls and sits at the control panel, a great contrast to the tar-covered operators of the old plant.

A new process for the extraction of fat from bones in the manufacture of glue has been introduced. This eliminates the usual extraction process, which involved the use of a large amount of inflammable solution and also considerable handling of material of an objectionable nature. In addition, the new process is continuous and automatic and removes the necessity of storing large quantities of unprocessed bones, which harbour flies and other pests.

In a new factory manufacturing television tubes, the process has been mechanized throughout and automation has reached such a point that it would appear in certain parts of the process that no human agents were engaged in it. Here, again, automation has reduced the risk of contact with dangerous chemicals or with their fumes.

Mechanical feeding of and extraction from machines is increasing and several developments, valuable from the point of view of safety, were noted in the woodworking trades. The adoption of such arrangements at power presses, which has long been advocated by the Factory Department for their value in preventing trapping accidents, is also gaining ground.

Production of transfer machinery for automation has been mainly confined to a few large firms, such as the big firms manufacturing motor cars, who have designed and made their own machines. Now, in one instance, a large engineering firm has reorganized its foundry and machine shops so that unit heads and transfer machines will be manufactured on a large scale. In this factory the electro-mechanical unit heads will be made in three sizes. Each size will be capable of being used singly or in combination with transfer machines to provide a flexible system for carrying out basic operations, such as drilling, tapping, milling, etc. Thus the system will be applicable to "batch" as well as to "mass" production.

Even in circumstances in which full automation would hardly be worth while, a number of firms are giving serious thought to some degree of electronic control. The need for the employment of highly-skilled maintenance men, electricians, engineers, etc., is, however, fully realized, and it is generally

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felt that, until the necessary training for such men has been greatly extended and improved, automation on a very large scale will not be possible.

Meantime, the increase in mechanization throughout industry generally is eliminating much heavy manual and dirty work formerly undertaken in factories, but, as will be seen in later sections of this Report, firms require to guard against any new risks to health and safety which may be introduced. Several Inspectors stressed that new methods of production bring new hazards in more complicated form. Chemical, electrical and engineering hazards may be found together in one plant; the old, clear borderlines between different trades tend to disappear. Sometimes methods of production have to be redesigned to meet the requirements of the Factories Acts.

Electrical Developments

Although nuclear sources of energy for industrial power supply are a major development of the present day, new ways of thinking about instrumentation, control, and the handling of information as well as of materials are, together with changes in economic factors, likely to produce changes more drastic than even the development of nuclear power stations. Direct applications of nuclear physics are already numerous, and it may also be expected that as these various techniques develop they will entirely change the face of industry. In the meantime, it is of interest to record some of the less spectacular but very important electrical and electronic developments now taking place, in particular in the heavier industries, which naturally lend themselves rather more slowly to such development than the light industries.

It is possible that we are seeing the beginning of a major revolution in the manufacture of steel. In 1953, a very important report was produced by the Battelle Memorial Institute, Ohio, U.S.A., on "Comparative Economics of Open-hearth and Electric (arc) Furnaces for Production of Low-carbon Steel", that is, for ordinary good quality mild steel. This report, which has been closely studied in England, shows that, because large arc furnaces of, say, 100-ton capacity can be installed for very greatly reduced capital cost compared with open-hearth furnaces, they may be more economical, in spite of the greater cost of heat supplied electrically compared with that obtained from solid or gaseous fuel. There are also advantages in easier handling, quicker charging and shorter periods for relining; there is also the possibility of using controlled atmospheres and therefore of obtaining more accurately controlled production. The first step in England was the installation of a 60-ton furnace near Sheffield, and further installations are planned for both England and Scotland. Apart from its economic and technical aspects, this development has important welfare applications. It is a step forward in that it removes much of the dirt and heavy manual labour from steel making; it also represents an important advance in smoke abatement.

Electrically-heated soaking pits with controlled atmospheres (with most of the energy taken at "off-peak" periods to obtain specially advantageous tariffs) have also been suggested. Another innovation arising from the development of the mercury-arc frequency converter, first in America and now in England, has already made high-frequency billet heating probable and, when the teething troubles have been overcome, even high-frequency ingot heating may be possible. Electrical smelting of iron ore in place of blast furnaces is being developed abroad.

There is nothing fundamentally new in these developments, but electrical equipment has now increased in size and reliability to a point where it can

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compete technically with solid and gaseous fuels for large-scale processes, and its simpler housing incurs less capital charge, so that it is beginning to have a financial advantage as well.

The other source of important changes is the modern technique of control and instrumentation. For example, small and medium-sized rolling mills have already been designed in which it is possible to maintain the adjustment of the rolls by servo-mechanisms (closed circuit controllers) independently of the skill of operators, and strip mills and wire drawing machines have been built in which the tension and speed of rolling or drawing are adjusted in a similar manner. There is now no technical reason why a large rolling mill should not be built in which a "program" is pre-set and carried out entirely automatically. The necessary techniques already exist; when, and how far, such methods are adopted depends largely on economic factors.

The way in which instrumentation may develop can be illustrated by the following examples. It is quite simple to mount an electron camera so that the melting shop manager or metallurgist sitting in his office can comfortably watch on a television screen the melting of the charge and the slag reactions. The television technique is already being applied experimentally to power station boiler furnaces and to the observation of dangerous processes.

On the other hand, equipment is available by which a detailed analysis of a sample from the melt is carried out automatically in one or two minutes by means of rather complicated electronic apparatus and either indicated on a set of dials or recorded on a chart. The results could quite easily be transmitted automatically by teleprinter and typed out in the melting shop manager's office as they are obtained. Compressed air tubes, similar to those used for "change" in some retail shops, are already in use in some works for carrying samples from the melting shop to the laboratories.

Another instrument is available which records on a chart in a central office the operation of up to a dozen machines or processes and indicates by code letters the reasons for all stoppages. Similar equipment could equally well be used to plot quality-control charts automatically.

If we assume that in time the whole operation of producing steel will be supervised by a few technicians and that, except for maintenance work, practically all the heavy and dirty work will have been eliminated, we shall probably not be over-estimating the developments of the next few years. When this happens depends on fairly evenly balanced economic factors and not any longer upon technical skills and abilities. An important duty of the Department will then be to use its influence to ensure that the complicated mechanisms are self-correcting and "fail to safety".

Production control and the handling of materials present certain problems common to nearly all industries. An interesting development is the centralized, and largely automatic, control of materials and production at a new electrical manufacturing works. Motor stators are built in 30 basic types, incorporating about 500 winding variations, in sizes ranging from approximately ¼ h.p. to 5 h.p., for ten different speeds. The bulk of this work is for a definite and short delivery date to individual customers' orders. The complexity of the windings varies considerably, as does the skill of the workers who do the winding, and the problem is to keep each of over 100 persons continuously supplied with work suited to his capacity, so that there is no delay between jobs. Each job takes about twenty minutes, and the necessary material is assembled on trays in the stores, one tray for each job, and delivered automatically by a conveyor system so that each person always has a job waiting

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beside him. As soon as he has finished one job it is removed to a test "bay" by conveyor, and as he places the new job in his winding jig, a signal is automatically transmitted to a central control station (which can be compared with that at an electrically-operated railway signal cabin at a marshalling yard) and the preparation of an appropriate new job is commenced. The delivery of the material is by a sequence of conveyors and is entirely automatic, so that material comes to rest opposite the winding station and has only to be slid off the final conveyor. Practically all manual lifting of heavy material is eliminated. The control of the system is based on a combination of electronic and automatic telephone techniques.

The use of standard automatic telephone equipment for the control of railway shunting and signalling and for centralized control of power systems is now well established and is being extended to the gas industry. Industrial concerns, such as oil refineries and steelworks, are also interested. The use of this equipment has great advantages but also introduces matters which require special consideration, such as the inadvertent starting or stopping of machinery owing to faults in the remote control equipment or to failure of the channel of communication. General recommendations for the safe operation of such a control system can be outlined.

When these developments become effective, they will tend to increase safety in the heavier industries. Accidents from handling heavy materials should be reduced, as well as mechanical accidents arising from workers' own mistakes or carelessness, but, on the other hand, there is always the risk that control and supervisory equipment may not function correctly, and it may be necessary, in the interests of safety, for a great deal more thought to be given to electrical circuitry and automatic programming.

Some Electrical Aspects of Automation

The word "automation" means mechanization in industry and manufacture, and does not indicate the method by which the result is obtained. Basically, manufacture is a mechanical process performed by mechanical plant, but automatic operation may involve different kinds of systems, such as pneumatic, hydraulic, electrical and electronic. These systems may be used separately, or may be mixed when convenient, but, taking the overall picture, there is no doubt that the electrical and electronic systems will play a very great part, if not a major part, in automatic working. It is interesting, therefore, to consider the effect on electrical safety of the great increase in this kind of apparatus which is already taking place, and will do so cumulatively in the future.

A number of processes quite different in principle, and using quite different types of electrical apparatus, are commonly referred to under the heading "automation", and for our present purpose it will accordingly be convenient to distinguish between them.

(1) Manufacturing processes involving automatic transfer and handling of parts, and automatic operations such as pressing, drilling, milling, machining, etc., combined in some cases with automatic assembly in the production line, represent perhaps the most obvious form of automation. This form is being rapidly developed in such industries as the motor car industry and is well known. The latest plant which is being laid down in the industry incorporates automation to a very considerable extent.

In the main, this sort of work does not involve new electrical principles; rather, it applies known forms of automatic contactor-operated electrical

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control gear on a much larger scale than hitherto. Such gear may be obtained in one linked sequence of production machines, instead of being applied to separate machines in different parts of the factory. Electrically, the whole plant is complicated by virtue of the great multiplicity of circuits and components. Generally, it can be said that plant of this description can without difficulty be made safe from the point of view of the operators, mainly because few operators are needed and because they are removed from the points of possible physical injury and are posted at push-button control stations. The electrical apparatus has, however, to be maintained and serviced, and hastily made to work again after stoppages due to faults or failures. At this phase the safety prospect is less favourable; not only must plant be designed and constructed in full compliance with the Electricity Regulations, making use of those safety methods known to be most effective, but also the necessary training schemes must be planned and initiated to make certain that electricians and servicemen possess the requisite skill to keep the plant in good order and to ensure their own safety while so doing.

(2) Development in the field of automatically controlled machine tools is intense at the present time and the results bid to be far-reaching. Machining operations may be followed from a man-made master or, in more advanced systems, the information from a drawing may be converted into appropriate digital form and fed into a computer which controls a machine tool to turn, cut or shape the finished product within the required tolerances. Electrically, such machines may be complex, and if they are to be tended by an operator at any time during working, adequate safety features must be incorporated. For example, a rotary variable-speed machine may need to be inherently incapable of overspeeding, in order to prevent consequent danger to life or limb; if not, then efficient checks must be provided by safety switches, etc., to prevent dangerous excess speed.

(3) Automatic electrical or electronic controls of continuous manufacturing processes, e.g., oil refining and chemical engineering in which liquids, gases and powdered solids are handled in bulk, are already well-established. The techniques of these controls are being rapidly further advanced. They are highly ingenious instrumentally and mathematically and enable processes to be carried out with a precision and on a scale hardly visualized a few years ago.

Here the question of electrical safety is in terms quite different from those of the last two above-mentioned items. In brief, it may be said that, technically, the means for ensuring safety are available, for they are inherent in the reliability of the processes; in addition, electrical alarms, warning signals or tripping and shut-down devices, as appropriate to the particular application, may be used to provide an independent overall check on the safety of the automatic control. The general design of automatic controllers and instrumentation is such that there is no difficulty in arranging for monitoring at a central point where the plant is under the supervision of the operating personnel. This gives to the operators a knowledge of what is going on as well as an ability to control the plant to an extent which was not possible with old methods, in itself a considerable step towards overall safety.

(4) Electronic computers, in addition to their use as part of automatic control systems, are now being used to extend our basic scientific knowledge in many industrial applications, such as fluid flow, heat transfer, electrical transients, etc., and to solve problems in these fields. This, indirectly, has a bearing on the improvement of industrial safety. A case in point is the stability of large interconnected electricity supply power systems

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which can now be studied far more precisely than hitherto, and greater knowledge of system conditions is enabling considerable progress to be made in the design of protective gear. As another example, by studies carried out by means of computers, the design of extra-high-voltage transformers is being altered to make them safer against the effects of high-voltage surges. Both digital computers (which work with numbers) and analogue computers (which work with instrument readings) are available and are being employed to solve problems which can hardly be approached by other means. In each of the above categories, electronic equipment may form part of the apparatus employed in a given application, and it must be recorded that much of the earlier electronic equipment, and even some of that produced today, is built more to the standard of apparatus for entertainment purposes such as radio, than to suit the arduous conditions met in factory premises. Insufficient attention has been given to protection from dust, fumes, moisture and dirt, as met in factories, and components have not been liberally-enough rated. The failures consequent on such competitive forms of construction have tended to prejudice the factory manager against electronic equipment in general, but various factors are now tending to restore confidence in what has already become an indispensable part of industrial equipment. A number of the more progressive makers have tackled the problem and have produced electronic apparatus of first-class design and construction, adapted to factory conditions, and thoroughly reliable. Again, the trend in design is leading towards the component with no moving parts and with nothing to age or to deteriorate, e.g., the transistor is tending to replace the vacuum tube. Also, developments in magnetic materials are resulting in such devices as magnetic amplifiers, which are permanent structures not subject to wear; these, though not actually electronic, are built into electronic equipment where appropriate.

Electricity Supply

The installation of new generating plant continued on a large scale during the year, there being an increase of 1,922 MW in total installed capacity, equivalent to 9·3 per cent of the total capacity at the end of 1954. These figures include plant in Scotland, as well as that of the Central Electricity Authority. Total units generated were 80,151 millions, an increase of about 10 per cent over the output in 1954. Generating capacity kept pace with demand for supply during the year; there was no load-spreading, and load-reduction by disconnection of supply occurred on one occasion only. Despite the very large amount of new plant being installed, it was still necessary to retain in commission many of the obsolescent generating sets.

During the year, several stations used new or unusual methods of steam generation. The first generating station to use steam raised by oil-firing came into partial operation during the year, and constructional work reached an advanced stage on the first station designed to use the heat derived from nuclear reaction. The latter station will be of somewhat experimental nature, but the sites have now been chosen and preliminary work has started for the first two of the proposed twelve main generating stations using atomic energy. Construction of a further experimental atomic energy station, using the "fast breeder" type of reactor, is well under way, and this form of reactor may become the standard for future stations.

The electrical generating plant and auxiliaries of the new atomic energy stations are expected to be of conventional type for the present, and, so far as these items are concerned, will raise no problems in safety which have not been already encountered in coal-fired stations. The absence of the large

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amount of electrical equipment associated with coal and ash handling, often operating in dirty and wet situations, and sometimes with exposed live trolley conductors, will in fact be a positive contribution to safety and to easier maintenance. The same remarks apply to oil-fired stations, although the enhanced safety thus obtained may be somewhat offset by the increased fire risks associated with storing and handling oil instead of coal.

The control of nuclear reactors, involving, as it will, much electrical instrumentation and electronic apparatus, places on the engineer great responsibility for the design and maintenance of reliable equipment to supervise the critical and dangerous fission process.

Notwithstanding developments in nuclear energy, pulverized fuel will continue as the main fuel supply for many years to come, and during the year further advances have been made with this system of firing. Newer boiler plant incorporates the cyclone principle, for which many advantages are claimed, including higher efficiency, greater evaporative capacity, greater flexibility, the use of low-grade fuels and a considerable reduction in the amount of fly ash passing through the boiler.

As regards boilerhouse design, the semi-outdoor pattern, recently developed, has proved extremely satisfactory.

In the design of electrical generating plant, the salient features seem to be the rapid increase in the use of hydrogen-cooled machines, and the projected large generating units of up to 200 MW output. Although hydrogen cooling is very likely to become standard practice for all large generators, some problems in its application still remain to be solved. As an example, the question arises as to the desirability of checking the release of gas from the make-up cylinders in the event of a sudden loss of gas from the alternator casing. Since the loss may already be associated with explosion or fire, the adoption of means of limiting the damage as far as possible may be desirable.

Progress has been made in centralized controls for power station plant, so that in the new larger stations there is complete control from one position.

Attention has previously been drawn to unsatisfactory design and arrangement of some switchgear and control panels for station auxiliaries, and Inspectors continued to find causes for complaint in this respect. Criticism has also been directed against auxiliary switchgear of the "quart in a pint pot" type, where the main factors in design appear to be the saving in space, and possibly in cost. While reduction in size of switchgear panels is desirable in itself, it may often be gained at the expense of facilities for easy and efficient maintenance.

A further point of interest is the continued occurrence of accidents in "isolated" switchboards or cubicles due to electricians, or semi-skilled men, coming into contact with live conductors. This subject is as old as the industry, but it is again necessary to emphasize that so-called "isolated" switchboards or cubicles should in fact permit no access to live conductors in the ordinary course of work. Guards over incoming live conductors should either be an integral part of the structure or, if removable, should be clearly marked to indicate that they conceal conductors which may be live even when the isolating switch is open. The point is important, as the potential fault energy available at station auxiliary switchboards is very high, and risk of severe or fatal burns exists, even if there is no contact of the person with the conductor.

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On the transmission side, further extensions of the 275,000-volt supergrid were completed during the year.

As a result of increase in generating capacity, it was necessary to replace many of the original 132,000-volt oil circuit-breakers by air-blast gear, while a number of others have been modernized and their breaking capacity increased. In one area, a large reactor was installed to reduce the short-circuit KVA to a figure within the capacity of the existing gear.

An extensive programme of site-testing of 132,000-volt circuit-breaker bushings was carried into effect, and this resulted in the replacement of approximately 5 per cent of the bushings.

In an effort to standardize switchgear, an agreement was reached between the Central Electricity Authority and the manufacturers on a specification for 6·6-kV. and 11-kV. gear, and it is expected that this will be extended to 415-V. and 33-kV. gear in 1956.

One large firm of switchgear manufacturers has decided to provide power operation, as distinct from hand closure, on all 6·6-kV. and 11-kV. circuit-breakers above 150 MVA rating, and on all circuit-breakers above 11-kV. This has been emphasized as desirable by this Department for a long time and is welcomed as a very definite step forward in design.

A great deal of work was undertaken during the year by the Area Boards, and many schemes were completed for the replacement of obsolete equipment, for system reinforcement and extensions to high-voltage and medium-voltage networks for new housing, and factories. It is probable that the volume of maintenance and reinforcement work undertaken and completed will exceed that accomplished last year. In many cases the results will be the best achieved since the war.

It will readily be appreciated that work of this type necessitates a large number of switching operations and the isolation and earthing of high-voltage equipment. Particular care is called for in the handling of networks temporarily operating under abnormal conditions. Under these conditions, when parts of the distribution system are made dead to enable work to be carried out, extreme caution is required, both during switching operations and also in the issue of permit-to-work cards, to ensure that a full assessment of the situation has been made.

Considerable attention was given to the performance of existing protective gear, and as a result, the percentage of faults correctly cleared was increased by 6 per cent. Notwithstanding this highly satisfactory overall attainment, some further examples of unsatisfactory protective gear were noted during the year. A short-circuit on an auxiliary motor control panel, equivalent to a 400-volt busbar fault, was sustained for about one minute, causing serious damage but fortunately no injury to personnel. The protective gear settings were too high and had been chosen to permit two sets of auxiliaries to operate from one auxiliary transformer. Also, the protection was operated from the high-voltage side of the transformer, thus further tending to coarsen the effective setting in relation to medium-voltage faults. The Regulations require that all parts of all circuits should be effectively protected against excess current, and to ensure this it may at times be necessary to provide protection between transformers and medium-voltage busbars.

The greatest single cause of electrical accidents on supply systems is still the conduct, or rather misconduct, of work which involves the handling of,

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or approach to, conductors, especially high-voltage conductors. The essential qualities of safe working methods and permit-to-work cards are now well understood, but cases still occur where work is not carried out in accordance either with the letter or the spirit of these methods. Several incidents again showed that the dangerous period in such operations is the preliminary work of isolating, testing, and earthing, often before the issue of the permit-to-work card. The latest recommended form of permit-to-work card attempts to cover this work effectively, but in the end, safety depends on everyone concerned paying the closest attention to the proper conduct of himself and others in what is potentially a most dangerous situation.

The use of a potential indicator on conductors, believed to be dead, before any attempt is made to apply an earth connection, is regarded by the Department as a most important step in rendering apparatus safe for handling. It was therefore disappointing to find cases where potential indicators were not provided for the use of operating staff. Other methods of potential testing, apart from earthing through a circuit-breaker, are liable to be unsafe.

Ionising Radiations in Industry

In reviewing radiological developments in 1955, the chief impression gained is that, apart from the exciting prospects of bringing atomic power stations into action in the near future, the uses of ionising radiations in industry are now well established. The pace of development has slowed down and, though new applications continue to be found and exploited, the main trend is for increasing numbers of firms to use radioisotopes for existing and well-tried purposes such as gamma radiography, thickness-gauging, static elimination, and tracer work.

The steady growth in the supply of radioisotopes to industry is illustrated by the figures in Table 1, which show deliveries of artificial radioisotopes to industry from the Atomic Energy Authority's establishments at Harwell and Amersham, the only internal sources of supply available to purchasers in this country.

TABLE 1

Deliveries to Industry (U.K.) of Radioisotopes (excluding natural radioelements) from the Atomic Energy Research Establishment, Harwell, 1947-55 (including deliveries from the Radiochemical Centre, Amersham, since 1950)

1947	1948	1949	1950	1951	1952	1953	1954	1955	Total 1947-55
—	19	88	437	558	650	910	1,180	1,450	5,292

Consistently, year by year, the annual deliveries of radioisotopes to all consignees have increased, while in the last few years the percentage for industrial use has been growing steadily.

These radioisotopes are used in approximately 300 factories. In addition, about 35 factories are using radioactive luminous compound and are subject to the Luminising Regulations, and a further 200 factories are known to make use of X-rays for radiography, fluoroscopy or crystallography. This figure is known to be an under-estimate of the total number of industrial X-ray users, but, as these are not yet subject to any Code of Regulations, there is no convenient means of discovering every industrial X-ray installation. The Factory Inspectorate continues to receive weekly notifications from

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Harwell and from the Radiochemical Centre, Amersham, of radioisotope deliveries to industry, and these notifications are of the greatest use to the Department in ensuring the safe use of radioisotopes. The information available thus suggests that, up to the end of 1955, at least 535 factories have found uses for ionising radiations in their production or research departments, following the direct purchase of radioisotopes from Harwell and the Radiochemical Centre, or the purchase of natural radioelements (chiefly radioactive luminous compound) from the few private firms specializing in this field, or of X-ray sets from the well-known makers of these appliances.

In addition, there are numerous factories, the exact number of which is unknown, using various instruments and devices incorporating small amounts of radioactive material. Examples of these devices are radioactive thickness-gauges, which are used in many factories, Thallium 204 static eliminators (of which over 3,000 have been installed in the textile industry for eliminating the fog-marking of nylon, acetate rayon, etc., when standing overnight in looms), small Thallium 204 beta-emitting foils fitted in laboratory precision balances to prevent balances sticking or giving inaccurate weights due to static electrical forces, and the increasingly popular fire and smoke detectors, devices whose functioning depends upon a small amount of the very long-lived radium element in a safe foil-form. It would clearly be impracticable for the Inspectorate to visit every factory using such instruments or devices incorporating small quantities of radioelements and to monitor the installations. The policy here is to make the most careful assessment, in collaboration with the makers, of the radiological safety of such instruments and devices at the prototype and design stages so that they may subsequently be marketed and installed in factories without, in normal cases, the need for any individual monitoring. It is a pleasure to record that the Department has received the most wholehearted collaboration from the makers; in fact, the initiative has almost invariably come from the makers themselves.

X-ray rooms and installations installed and monitored in 1955 were found to be, with one exception, well up to the high standards set in the Department's advisory publications, and in the exceptional case, plans for remedying the defects noted have since been submitted to the Department.

In my Report for 1953, reference was made to the construction in this country of the first 1 million volt X-ray installation in an open pit some 20 ft. below factory floor level. The Department had been consulted about the protection and safety features of this installation, which was completed during the year under review and carefully monitored by representatives of the Factory Department and the Radiological Protection Service. The underlying principle of pit-working is that the unattenuated beam shall never escape from the confines of the pit and its surrounding walls. Under these circumstances, the protection problem is greatly reduced, the only radiation which has to be considered being leakage radiation from the X-ray equipment and scattered radiation from the useful beam. Any escaping radiation is confined by the walls of the pit to the upward direction; the shop floor surrounding the pit is therefore subjected only to secondary scatter. Workers occupying elevated sites, e.g., crane drivers, can however be exposed in some positions to the primary scatter and to leakage radiation, according to the conditions of tube use. (If the useful beam were to escape from the pit, the shop floor would be subjected to primary scatter and overhead workers might be subjected to the useful beam itself. Dose-rates would then be very much greater and restrictions on the use of neighbouring space would need to be much more stringent.) The million volt X-ray tube is capable of producing two useful

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beams (a) forwards and (b) sideways. It is clearly advantageous to restrict unwanted radiation to the minimum and consequently, unless in the most exceptional circumstances, only one beam or the other will be used at any one time, the unwanted beam being attenuated to such an extent that its contribution to the stray radiation leaving the pit is small. This will be achieved by the use of annular lead absorbing pieces or end shields on the tube anode, and the former will be used to restrict the sideways beam to sectors below the horizontal. With the above arrangements, which include a complete set of interlocks to control access to all dangerous positions, on the basis of a maximum of five hours' excitation of the tube per week, the monitoring surveys so far made have shown that the installation can be operated with complete radiological safety. It has even proved possible to allow considerable relaxations from the restrictions originally imposed on the use of floor space surrounding the X-ray pit. As opportunity permits, it is hoped to carry out further monitoring surveys of this plant under a wide variety of operating conditions and to make a study of the "air-shine", i.e., the radiation back-scattered downwards from the air molecules above the radiating source, a subject on which little is at present known.

There have been no new developments of note in the industrial use of X-rays for fluoroscopy and crystallography. The use of radioisotopes for the gamma radiography of castings and welds, which was reviewed in some detail last year, continues to gain in favour, but otherwise conditions remain much as before, except that the greater availability of the long-lived Caesium 137 radioisotopes (33 year half-life) has caused some firms, though far fewer than might have been expected, to change over from the hitherto-popular Iridium 192, which has comparable gamma ray emission energy, but a comparatively short half-life of 74 days.

Among the gamma radiography rooms inspected and monitored one was found which had walls of corrugated iron insufficiently thick in relation to the room size and to the strong Cobalt 60 sources in use to give the proper standard of protection to workers passing outside or to the occupants of a neighbouring private house when in their garden. As the lease of the premises had nearly expired the problem was dealt with by building internal brickwork protection, some 18 in. thick, close round the panoramic exposure position.

In a new gamma radiography plant containing a two-Curie Cobalt 60 source, access doors to the plant (themselves protected by thick concrete "blast walls") have been interlocked with the source control gear, operated from outside, to prevent the source being exposed until all access doors are shut. This arrangement is similar to the existing interlocking principle so widely employed in X-ray room design and will have to be more and more widely followed by industry as radiographic sources increase in strength.

The extent of compliance with the Luminising Regulations was discussed last year. Apart from this major use of unsealed radioactive luminous compound there continued to be, in the current year, very little industrial use of other forms of unsealed radioactive material.

Advice has been given to a number of firms on the precautions which should be taken when handling or storing some of the many different types of radio and other valves now containing small quantities of radioactive materials, chiefly radium bromide, Cobalt 60, or Tritium. These materials are incorporated in order to enable the valves to comply with specifications for ionisation time or potential, recovery time and useful life. The chief risk

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is that accidental breakage of the glass envelope may cause cuts or wounds contaminated with radioactive material.

Collaboration has been continued with International Bodies, such as the International Labour Office and the International Commission on Radiological Protection, which are actively considering the best way to secure world-wide agreement on the labelling of containers of radioactive materials and on the adoption of a distinctive warning symbol.

The Department was consulted on the design of a small laboratory to handle radioactive piston rings in connection with lubricating oil researches and engine wear experiments. After the advice of the Department was sought in each case, the following other uses were made of radioisotopes: Sodium 24 was used in the determination of optimum efficiency conditions in the mixing of trace elements with animal foodstuffs, and in studying the rate of throughput in a cement production ball-mill. Manganese 56 was used in experiments on mixing-efficiency determinations in the manufacture of animal foodstuffs. Lanthanum 140 and Sulphur 35 were used for determination of slag mass in electric arc furnaces and Zirconium 95 was used for tracing the origin of honeycomb slag and in investigations of the iron ore sinter process. Copper 64 was also used for mixing efficiency tests.

The use of radioactive foils, prepared by the Radiochemical Centre, containing a wide variety of radioelements, chiefly beta-emitters, continued to gain in favour, particularly in the manufacture of industrial thickness-gauges and static eliminators. There are also other uses for these foils, for instance, in a particular type of fire and smoke detector and in certain cold cathode valves. These foils contain the radioactive material in solid solution in a noble metal of very high melting point, usually silver or gold, rolled out between two thin foils of pure silver or gold. In this form, radioactive materials are completely sealed and cannot be dispersed (either by accident as the result of fire, or gradually as a result of the normal operation of the process), though the user must protect devices incorporating such foils from rough and unnecessary handling and from the action of abrasive or corrosive materials.

The year was notable for three events. The first was the publication in May of the revised "Recommendations of the International Commission on Radiological Protection",* a document of 92 pages giving, for the whole range of ionising radiations, the basic protection data at present available. In addition, the document sets out permissible body burdens and permissible air and water concentrations for a large number of radioisotopes now encountered in occupational exposure. Its standards, representing the work of groups of international experts over a period of years, are those to which the Factory Department adheres in its day-to-day protection work and will form the basis of any future regulations which may be promulgated for the industrial use of ionising radiations. It is clear that sufficient practical information and guidance is now available on standards of exposure to ionising radiations to cover nearly all cases of occupational exposure likely to be encountered in the next few years.

The second event was the holding at Geneva, in August, of the first World Conference on the Peaceful Uses of Atomic Energy, an outstandingly successful occasion. The wealth of information released in the 1,100 or so papers presented to the Conference will be of the greatest possible value to industry

*Obtainable from The British Institute of Radiology, 32 Welbeck Street, London, W.1.

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in developing existing and new projects in the atomic energy field and in extending the industrial uses of the by-products of this industry and the uses of ionising radiations generally. At this Conference, considerable attention was devoted to the subject of radiological protection in all its aspects, and the Factory Department was honoured by an invitation from the International Labour Office for one of its specialist Inspectors to prepare and present the I.L.O. contribution to the Conference, a comprehensive 66-page report on "The Protection of Workers against Ionising Radiations".

The third event was the transfer at the end of the year of the radiation film badge service from the National Physical Laboratory to the recently constituted Radiological Protection Service run jointly by the Ministry of Health and the Medical Research Council. The film badge service for medical workers, commenced by the National Physical Laboratory in November, 1942, was extended to industrial and research workers five months later at the request of the Factory Department. Between 1942 and the end of 1955, over a quarter of a million films have been issued, the great majority to industry.

Table 2 shows the analysis of the results of the film badge tests for industrial and research workers only. It should be made clear that by no means all workers in industry exposed to ionising radiations make continuous use of the film badge service, but it is also known that, in every case, those who do have lower averages than similar persons in the same group having occasional tests. Within these limitations, certain conclusions can be drawn.

TABLE 2

ANALYSIS OF NATIONAL PHYSICAL LABORATORY RADIATION FILM-BADGE TESTS FOR INDUSTRIAL AND RESEARCH WORKERS

Radiation group: dose received (röntgens per week)	Percentage of workers submitting film badges in radiation group, averaged over period		
	1943-1950	1951-1952	1955
Less than 0·05	67·7	71·7	86·8
0·05—0·1	15·2	12·8	7·8
0·1—0·3	9·6	12·5	4·4
0·3—0·5	2·5	2·1	0·5
Greater than 0·5	5·0	0·9	0·5
TOTAL ...	100·0	100·0	100·0

Over practically the whole of the period covered by Table 2, viz., from 1943 to 1955, the maximum permissible weekly dose, as measured by film badge, was 0·5 röntgen, and the Table shows that there has been a very considerable reduction, over the thirteen-year period, in the percentage of workers submitting film badges indicating exposure in excess of 0·5 röntgen. During 1955, the International Commission on Radiological Protection recommended a maximum permissible weekly dose of 0·3 röntgen, and even on this basis there has been appreciable improvement during the thirteen-year period. During this period, there has been a corresponding steady increase in the percentage of workers whose film badges indicated a dose of less than 0·05 röntgen per week.

These changes in the distribution naturally mean an improvement in the general position, but do not necessarily mean that all the individual workers submitting film badges in the earlier periods are now receiving less radiation.

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The explanation may be that many workers who have recently begun to use the film badge service are receiving less radiation than the "old hands", either because they are engaged in safer processes, or because processes more recently begun are conducted in a safer manner. There is, however, some evidence during the past four years of a reduction in exposure of persons engaged in the relatively old process of luminising.

The analysis of the film badge tests shows the very marked improvement which has taken place since the commencement of the service, an achievement which is the more impressive when considered in relation to the very great increase in the use of ionising radiations which has taken place during the same period. This achievement is a tribute to the painstaking work of the National Physical Laboratory and to the efforts made over the years by the Laboratory, jointly with the Department, to assess accurately the radiation risks and then to remedy, by monitoring surveys and inspections, any adverse conditions likely to give rise to excess dosage. I should like now to record, on behalf of the Department, my gratitude to the National Physical Laboratory for this beneficent work in the field of radiological protection. At the same time, we welcome the new organization and look forward to many years of fruitful collaboration.

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PART I. SAFETY

CHAPTER 1

Review of Progress in Safety

ALTHOUGH there is nothing spectacular to report, methods of guarding are being steadily improved to a degree which augurs well for a substantial reduction in machinery accidents if the improved methods can be sufficiently widely applied. Obviously, this can best be achieved by incorporating the guards in the design of the machine, so that the machine on reaching the user will be safeguarded to the greatest extent practicable at that stage. The user may still have to provide "point of operation" guards, of which the actual form may well depend on the nature of the work done and on the manner of working; nevertheless, there are many machines for which complete fencing can to advantage be provided by the maker, and these will almost certainly be machines which have been designed for particular methods of working.

Consideration of safeguarding by the maker should mean making provision for guarding at the design stage and this may well result in the elimination of many points of danger which would otherwise require to be guarded. In some cases, dangerous parts which cannot be eliminated may, with a view to safety, be so constructed and arranged as to be completely enclosed within the machine-casing; approach for lubrication or other maintenance operations can be obviated and the risk of a detachable guard not being replaced does not arise. There will, however, be many cases in which guards have to be removed or displaced to give access to the tools or the machine mechanism, and the risk of such guards not being replaced can be obviated by the provision of interlocks which ensure that any motion of the machine can only take place if the guard is in effective position. Even where it is not practicable for a machine maker to provide a guard for a particular part, it is helpful if interlock fitments are provided on the machine to enable the user to fit a guard which will make motion of the machine dependent on the guard being in position.

Interlocks

Machine users are becoming more and more aware of the importance of interlocking to ensure that machines are not worked in an unguarded state. Inspectors report many instances in which fixed guards for operational parts have been fitted with interlocks. The design of interlocks is of great importance if their purpose is to be achieved, and an essential feature is to ensure that the interlock system cannot be interfered with so as to allow the machine to be worked with the guard open. An interlock which depends on depressing a button, or on a peg entering a hole and completing a circuit, should clearly be made inaccessible. In the example of an interlock on a machine guard, a good method is to use a cam and roller in such a way that the roller is both forced into and held in the "safe" position by the cam when the guard is opened and is returned, by a spring or by gravity, to the operating position

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when the cam itself moves to the "operate" position (i.e., when the guard is closed).

To achieve a safe condition, it is always preferable to break rather than "make" an electrical circuit, since dirt, failure of the mains supply, or an open circuit elsewhere will defeat a "make-circuit" device. On the other hand, it is unwise to interlock an enclosure or mechanism so effectively that the maintenance staff cannot carry out such adjustments and inspection as may be necessary with the circuits alive; otherwise, sooner or later, the interlocks will be dismantled and may not be restored. It is best to arrange the interlock so that it can be put out of action temporarily by a skilled man in a recognized manner, but so that the apparatus cannot be brought into service again without the interlock being reset. Well-designed proprietary apparatus embodying this desirable feature is readily obtainable.

The satisfactory interlocking of a guard intended to prevent access to moving parts of machinery also necessitates bringing the moving parts to rest before the guard can be opened. In the case of a machine having a considerable run-down time this may require the fitting of a delay-action mechanism, but in the case of new machines it should generally be possible to arrange practically instantaneous stoppage for those parts likely to be exposed by attempts to open the guard before the parts have come to rest.

The principle of the captive key as a form of interlocking is used in a number of cases. Here, the application of power is dependent on the insertion of a key into the circuit, so that the key cannot be moved unless the circuit is open. The same key is used for the guard and is held captive in the guard lock until the guard is closed. With only one key available, the guard cannot be open simultaneously with the running of the machine. Following a very serious accident at a machine, not fitted with a suitable braking mechanism, which had a run-down time of 35 minutes, an interlocking system was installed which had nine locked bolts, involving the use of captive keys in delay-action sequence, so that it was impossible to complete the key exchange and open the interlocked covers before the machine came to rest.

A system has been evolved for interlocking the guards on hydraulic moulding machines so that the opening of the guard actuates a relief valve in the pressure circuit, the slightest movement of the guard from the closed position allowing all pressure to be dissipated.

An interlocked guard was developed in one factory for a triple-roll paint mill. This guard consists of a feed-hopper which provides fencing for the nip of the rolls. Removal of the guard opens a switch and brings the machine to rest, thus preventing access to the nip when the rolls are in motion.

Automatic machines, such as are used for wrapping, etc., often cause accidents when a worker tries to correct a fault by removing, say, paper which has become twisted, without first stopping the machine. One firm has dealt with this problem by providing guards, made of transparent material, which cover the whole of the danger area and by interlocking the guards with the driving motor. At another firm, several serious accidents on automatic packing and labelling machines had been caused when the operator saw a wrongly-folded packet travelling through the machine and tried to snatch it away without first stopping the machine. The firm affixed numerous guards over different parts of the machine, but then another accident happened at some other part. They finally decided to enclose each machine completely by a mesh guard with interlocking connections, so that if any part of this enclosure were removed the power was cut off from the machine.

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Photo-electric devices

Photo-electric devices are in use in industry as controls in a large number of applications, for which they appear to be eminently successful, but in the field of safety the keynote has been one of caution. The Joint Standing Committee on Safety in the Use of Power Presses, in reporting on the application of these devices to the safeguarding of press brakes, drew up a standard of installation and performance. Where these devices are fitted in accordance with this standard they are proving satisfactory. There have, however, been cases of imported machines provided, in place of guards, with photo-electric devices which have not given the requisite standard of performance. Not only did the imported device itself not have the essential characteristics of being self-checking and of failing to safety, but the response-time of the device and the stopping-time of the machine to which it was applied were not sufficiently rapid to prevent injury to a worker reaching through the protecting ray to the point of danger.

The photo-electric cell provides a useful method of protection where guarding by more orthodox methods is either difficult or impracticable. One such application was to a machine used for wrapping small surgical dressings in paper. The mechanism of the machine was somewhat complicated and included gears, knives and gluing and sealing devices. Due to the need for frequent adjustments and setting for different sized bandages it was found impossible to safeguard the dangerous parts by fixed guards or even by interlocked guards, and it was decided that the best method of safeguarding was by electronic means using a photo-electric cell. In addition to the protection afforded by the photo-electric cell device, risk of accidental approach to the machine was reduced by the provision of fencing by means of plastic sheet guards up to a height of 5 ft. from the floor, except at feeding and discharge points.

Dangers arise not only on the self-contained automatic machine but also on machines operating in automatic sequence. A firm of machine-tool makers which originated the principle of transfer machines in factories over thirty years ago, makes the various machines (e.g., multiple drillers, reamers, borers, millers) forming the sequence, sets them up on the test bench before despatch and then assembles them in the particular factory where the flow line is required. These transfer machines, which are being used to an increasing extent in the motor car industry, have introduced certain hazards. The machines may incorporate as many as thirty different heads, all of which operate on a pre-determined synchronised time-cycle. There is the danger that a person carrying out an adjustment or repair to one of the heads may sustain injury if the machine is then set in motion. To guard against this, one of the large motor companies is experimenting with a combination of photo-electric cells and Castell keys. These have been fitted on a six-head machine used for drilling and milling. The photo-electric cells are placed around the outside of the machine and whenever a person approaches within 4 ft. a warning bell rings on the control panel. If the person continues to approach and gets into a dangerous position, further cells are brought into action to cut off the power from the machine. Nothing can then be restarted until the mechanism has been reset at the control panel. Risk of injury to a tool-setter when carrying out adjustment has been dealt with by a system of Castell keys. Each working head is fitted with a set of isolating buttons for use when setting up the machine and if any one of the buttons is pressed the machine stops. Accidents are possible, however, because the machine can be, and usually is, started from the main control panel. To prevent the machine being so started while a setter is at work on it, the Castell key which has to

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be used to operate a switch on the control panel is removed from the panel to operate the isolating button at the working head. This prevents the machine being set in its full cycle of operation from the control panel but permits the particular head to be inched as desired by the setter.

Limit Switches

With the growing use of automatic controls, more and more limit switches are employed. Designers of these do not always consider the consequences of "failure to danger", which can easily occur with most types through the development of a small defect. The consequences of such failure are of the greatest importance where the limit switch is introduced to guard a dangerous part of machinery or plant.

An examination of a representative selection of switches was undertaken, and one result which emerged was that a switch relying on springs could not be expected to "fail to safety" in all circumstances. Other points of importance were the position in which the switch was placed and the manner in which it was connected. For instance, to choose a switch which allows the contacts to fall "on" to actuate a conventional shunt circuit is asking for trouble. On the other hand, to turn the unit upside down, or to select another pair of contacts within it so that the connections fall "off" is often possible. To place it in a position where it could be shorted by the ingress of conducting cutting oil, soap solution or condensate, as was found to be so often the case, is also bad practice. In this connection, it is perhaps as well to emphasize that cutting oils of the non-soluble type can give rise to trouble when they become carbonized by the high temperature developed at the tool.

Selecting a unit which can be readily tied up or defeated by a thoughtless workman, or placing it in a position where objects might easily fall upon it and close it, should be avoided.

Lastly comes the question of the method of connection of the limit switch in the circuit. Wrong methods have all given rise to serious accidents. The method of connection regarded as being as safe as is reasonably practicable although not giving complete immunity from risk, envisages the use of two single-pole switches connected in series with each other and with the contactor coil, the two switches being actuated by two completely independent mechanisms; the basis of the argument is that it is unlikely that two simultaneous failures will occur. It will, however, be appreciated that, in using switches which can fail to danger, to allow one to be permanently "on" will seemingly give proper working until the second fails. Regular maintenance should detect the first failure before the second occurs, but only on this condition will the circuit prove reliable.

There are very real troubles associated with shunt-connected control circuits, and it is hoped that this will be an encouragement to manufacturers to produce some series limit switches suitable for at least the smaller sizes of motors, which form a large proportion of the drives for moulding presses, bakehouse machinery and the like. By "series" limit switch is meant a switch in series with the main circuit conductors (as distinct from a switch in the control circuit of a contactor); when such a series switch is opened the circuit is directly broken without any possibility of remaining fortuitously energized.

Failure to Safety

The principle of "failure to safety", the classical example of which is the "dead man's handle" on electric trains, is now commonly accepted in the

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design of electric control equipment and electrically interlocking guards. In practice, however, it is not always clear exactly what the term implies in a particular instance, and how the desired effect is to be obtained. In general terms, an attempt is made to ensure that in the event of any foreseeable failure of plant or electrical supply, or mishap or neglect on the part of personnel, the apparatus in question will not become dangerous; and although there is no universal rule for achieving this end, it is possible to suggest certain principles which it is useful to apply so far as is reasonably practicable.

It is best to realize from the start that in practice the principle of failure to safety can be applied only in a limited way, and that in every electrical arrangement there will be features which do not "fail-safe", which must therefore be dealt with by good construction.

There is another practical consideration which limits the extent to which the principle of failure to safety can be pushed, because failure to safety involves stopping the dangerous machine or shutting down the circuits concerned, and if this is carried too far, it is likely to lead to a number of unnecessary stops or shut-downs. The personnel, and particularly the production staff, will not welcome this, and may then seek to defeat the whole device, as their first object is to keep the particular process running. Thus, in practice, a careful compromise must be made between the conflicting considerations of failure to safety and of keeping the machine running.

Investigations so far made seem to suggest that one of the best ways of ensuring safety is to employ an independent monitoring device to supervise the correct operation of the main control apparatus concerned; in other words, to provide an overall check to disclose all failures in the main apparatus. An overall check of this description is incorporated in photo-electric guards for press brakes and power presses. It has already become clear that there are many advantages in such an arrangement for, in practice, borderline danger conditions arise of which it is extremely difficult to take account by means of fail-safe circuitry alone. The fact that the overall check can cater for such borderline conditions adds much to its value. For instance, a photo-cell circuit might, as a safety precaution, be made responsive only to modulated light, as it would then not fail to danger if sunlight fell on the photo-cells. Such an arrangement, however, might fail if by chance the spokes of a flywheel in the shop modulated the sunlight in such a way as to hold the device in circuit although the beam was cut by the human operator. Such unusual, casual or chance events can never be individually foreseen and designed against, but they, and a number of others too various to specify, are detected by the overall check and the press is shut down. This discloses an important principle which may be developed according to the circumstances of each application.

The overall check will usually be cheap and simple. It is not required to do the same job as the main control gear, but only to detect a danger condition in the end-result. For example, control apparatus for fluid flow plants may be highly complex in order to obtain the desired characteristics for the process, yet the monitor may need only to detect excess level in a tank, or excess pressure in a pipe. In any case, a monitoring device should not cause additional expense, because it should be provided even if the main apparatus is manually controlled instead of being automatically controlled.

New machinery

The number of cases which came to notice in which there were deficiencies in the guarding of newly-supplied machines showed a reduction of 7½ per

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cent on the figure for the previous year. Apart from a number of machines not related to any individual industry, the deficiencies were again principally in machines supplied to the printing, food-processing, woodworking, textile and machine-tool trades. Printing machines represented 20 per cent of the total. The general standard of compliance with the obligations imposed by the Factories Acts upon machine suppliers is now good, but there remains a hard core of persistent offenders. Another perennial source of trouble lies in imported foreign machinery, for which new agents are continually appearing, while in some cases the machinery is directly imported without any agent in this country acting as intermediary. In many cases, agents have originally little or no idea of their statutory obligations under Section 17 of the Factories Act, 1937, and, even after they have been acquainted with the position, they often seem to think that their obligations have been fulfilled by notifying the makers. These agents should realize that it is their legal responsibility to remedy the omissions if the makers continue to supply machines not complying with Section 17.

While makers are becoming increasingly aware of the need for guarding gearwheels, pulleys, belts and the more obviously dangerous parts of machinery and for eliminating projections on revolving parts, the degree of protection often leaves much to be desired. It is still not always appreciated that all effective guards must prevent access for the fingers from every direction. The motorization of machines with individual V-belt drives is a case in point ; a guard which does not prevent access to the intakes between belt and pulleys on the side remote from the working position is not an effective guard, yet some makers still leave that side of the drive unguarded.

There is, however, no doubt that the standard of guarding provided by machine makers represents a great advance on that of only a few years ago. Nevertheless, much remains to be done and the position will not be really satisfactory until every machine is so designed as to reduce the number of dangerous parts to the minimum and until those remaining are guarded to the fullest possible extent before leaving the makers' works.

A number of electrical accidents are caused by faulty design, and during the year, in the assessment of one Electrical Inspector, about a quarter of the accidents in his area were attributable, wholly or partly, to faulty design.

Conveyors and Elevators

Increasing provision is being made for emergency stop push-buttons on conveyors and elevators, these being installed as an integral part of the machine. Such arrangements serve a very useful purpose but cannot be regarded as a substitute for rendering the installation safe by protecting all dangerous parts. A typical risk envisaged is that of trapping between trays and landing openings on continuous moving elevators where the trays move in fixed guides. In several cases, the danger can be obviated by reversing the direction of motion. Where this cannot be done, a form of trip-bar can be fitted to the leading edge of each tray. This, combined with a quick-stopping mechanism provided on the drive, should prove an effective safeguard.

More attention is also being paid by both makers and users to the proper guarding of belt conveyors. A British Standard Specification for belt conveyors has been drafted which contains illustrations of typical guarding methods for the various dangerous points. This specification is likely to encourage the provision of suitable guards by the makers and accidents on belt conveyors should be greatly reduced as a result.

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Cranes

In recent years the steel industry, through its research organization, has given considerable thought to the design of steelworks cranes and there is now in being a specification in which attention has been given to the incorporation of features making for safe working. Several overhead travelling cranes installed in a steel rolling mill brought forth the comment from an Inspector that the standard of safety for the operators and maintenance men has seldom before been equalled. On these cranes there are wide, easy access-stairways, all gangways and platforms are properly fenced and all lights are accessible from proper platforms. The crab, long-travel shaft, etc., are all securely fenced, all oil nipples, grease cups, etc., are outside the fencing, the cab is admirably fitted and an elaborate system of electrical safety devices is provided.

Lifts

A British Standard Specification in course of preparation concerns electric lifts. This specification is in three parts, dealing with outline dimensions, with constructional and safety requirements and with lift motors respectively.

There is a tendency for factory occupiers to attempt to construct a cheap lift by using an electric hoist-block as the power unit. An electric hoist-block is not designed for moving a guided platform or cage between floors and, not unexpectedly, accidents have shown that this attempt to cut costs has not proved economical in the long run. One point often overlooked is the necessity for a slack-rope or slack-chain switch. On a drum-wound machine there is the risk of the cage or platform being obstructed in its descent and if this happens the rope continues to be paid out from the drum, so that later, when the obstruction holding the cage is removed, the cage falls down the liftway to the extent of the free rope, imposing a severe strain on the rope, apart from causing other damage.

Hundreds of hydraulic hoists in use in making-up and packing factories in the textile trade have long been a serious safety problem. On numerous occasions interlocking devices for the gates have been found inoperative because of the difficulties of loading and unloading trucks or pallets of cloth on hoists of this type. The presence of a loaded truck in the cage has the effect of compressing the water in the cylinder and this small amount of compression is magnified (usually four times) by the reeving of the lifting ropes. The removal of the loaded truck at a landing, therefore, allows the cage to rise from 3 in. to 6 in. above the level of the landing, and another truck cannot therefore be loaded until the hoist has been levelled. When pallets are used to carry the cloth the position is even worse, as the hoist has to be re-levelled after loading in order to remove the trolley which carries the pallet. As the hoistmen's work is the continual transporting of cloth to and from the packing and making-up rooms, they soon discover ways of overcoming the difficulty of having continually to open and close the interlocking gates; although it is not always easy to detect, there seems little doubt that interference with the interlocking devices is almost a matter of routine. In order to overcome this, a firm of lift engineers developed a device which allows a limited amount of levelling at the landings while the gates are open and the general adoption of this device may well solve the problem.

Vessels containing Dangerous Liquids

The protection of tanks, vats or vessels of which the edges are level with the floor and which contain scalding, corrosive or poisonous liquids often

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presents considerable difficulty where unrestricted access is required. A firm of galvanizers, who specialize in components of very considerable length, provided fencing for one of their floor-level pickling plants by fixing rails at a height of 4 ft. from the ground. The rails are suspended from the roof. This arrangement allows an uninterrupted space below the bars through which the work can be put in and taken out. The length of the rail fencing is such that supporting bars are necessary at intervals, and if these supports were fixed to the floor it would be impossible to roll or push the work into the bath.

Woodworking Machinery

Among improvements in guarding which had been discussed in the past and which were incorporated into the standard of design of woodworking machines during the year are: the complete enclosure of the conveyor chain and the side protection of the pressure rollers of a tapeless veneer jointer, a hinged guard to protect the intake between the conveyor and the delivery table of a triple-drum sanding machine, and interlocked mesh guards for the nips between the doctor-rolls and the spreader-rolls of a glue-spreading machine. Electrical interlocking on glue-spreading machines had been tried in the past and had failed, because of the effects of glue and water on the limit switches. In this recent successful application, the switches are shrouded by the webs of channel sections forming part of the frame of the machine and are operated by curved rods, attached to the hinged guards, working through small holes in the frame members.

The substitution of interlock guards for bi-manual push-button controls on veneer-cutting guillotines represents an appreciable advance in the safety of these machines. In practice, the push-button control has proved inadequate since the depression of the two buttons, even if followed by the immediate removal of the hands from the controls, started the complete cycle. There was therefore nothing to prevent the operator's fingers being trapped by the blade or clamp.

One type of combined veneer-jointing machine and guillotine of foreign make is entirely automatic in action. It comprises steam-heated platens with a feed-mechanism at the front of the machine into which lengths of veneers are fed. They emerge at the delivery-end as a continuous strip and the leading edge travels over an out-rigger table, makes contact with a cam and causes the sheet to be cut to a predetermined size. The feeding is done through a gap so narrow that it is not possible for the operator's hands to be trapped by the veneer grippers. The guillotine blade is completely fenced at back and front and requires no attention on the part of the worker.

Printing

There was intense activity in the printing, boxmaking and allied trades during the year. New machines replaced many of the old out-of-date ones. It used to be said that a printing machine would last for 50 to 100 years, and it is true that many machines over 50 years old are still in use. However, developments in the printing industry are forcing out the older and slower machines. The use of high-speed machines drew particular attention to the amount of time taken in "making-ready". It was often found that the time taken in getting the machine ready was out of all proportion to the time taken to print. This led to an increase in what is known as pre-make-ready, where as much as possible of the making-ready is done away from the printing machine, so as to cut down to a minimum the time that the machine is not

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on production work. Formes can be prepared and proofs taken while the printing machine is still in process of an earlier job in the programme of work. A good example of this development is a new rotary letterpress machine so designed that the cylinders which carry the type can be easily lifted out of the machine. While one set of cylinders is in use another set can be in course of preparation in a "make-ready" machine.

From a safety point of view, this cutting down of make-ready time at the machine is an advantage. Many accidents occur at make-ready, because the machine minders try to save time by taking the risk of approaching dangerous parts of printing machines while they are in motion. If most of the make-ready can be done away from the actual printing machine the risk of injury is accordingly reduced.

A somewhat novel method of interlocking was adopted in a printing works where a number of small two-colour rotary printing machines were fitted with plastic covers completely enveloping each machine. Each cover is suspended from the ceiling and is counterweighted. To get at the machine, the operator lifts the guard as he would a sash-window and this operates an electrical cut-out. Originally the cut-out was fitted to the machine, but, being an ordinary contactor of the type used on lifts and being accessible, the possibility of interference was foreseen. Accordingly the cut-out was put out of reach at ceiling level and the possibility of running a machine with the guard out of position was eliminated.

A case was also noted of an interlock being fitted to ensure a trip-guard being in position. This concerned a platen printing machine for which the recognized method of fencing is a trip-guard, and in order to ensure that the trip-guard was not swung out of the way, a switch interlock has been fitted.

Food-Processing Machinery

In the baking industry more and more small bakehouses are closing down, and it would seem that, in the not too distant future, all bread manufacture may well be in the hands of a small number of large firms. This development may not be disadvantageous from the safety point of view, since such highly-organized specialization provides certain conditions, such as the employment of the most up-to-date machinery and the elimination of manual handling, which tend to make for greater safety.

The display of machines at the recent exhibition of bakehouse equipment showed a concentration on streamlining and appearance rather than on changes in fundamental principles of operation; lavish use was made of vitreous enamel and stainless-steel finishes. Such finishes take unkindly to any alterations or additions which may be necessary to accommodate safety equipment after a machine has been taken into service, therefore a maker must have regard to safety when designing his machine if its pleasing appearance, to which so much thought and attention has been given, is to be preserved. It is true that a genuine attempt is being made by many makers to equip their machines with safety devices, but there are still too many who believe that guarding a machine is a superfluity, which adds to the selling price and must therefore be skimped as much as possible. Evidence was strong, however, that the bakery industry had become more conscious of the necessity of guarding dangerous parts of its machinery and that the complaints of users exerted a strong influence on machinery makers. Reports indicate that publicity given through Departmental literature, articles in trade journals and lectures to the trade assist greatly to this end. Some of the

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leading makers have been extremely co-operative in making guards available for existing machines.

A disturbing feature, following upon the great impetus to safety given by the development of the interlocked guard for dough-dividers, was the tendency, particularly on night shifts where discipline is not always as good as it might be, for the interlocks to be deliberately put out of order by the men.

Three interesting developments are worthy of note in connection with dough dividers. Firstly, in some bakeries a small batch of brown dough is passed through the plant between the main batches of white. It had been the established practice to feed this direct into the divider hopper, thereby avoiding the laborious task of cleaning the main feed-chute, which would have been necessary if the dough had been fed via the chute. The normal interlocked hopper guard prevents this practice and, to overcome this difficulty, a guard which combines the features of chute-feed with those of hand-feed has been developed. The combined extension is swivelled and can be swung aside for cleaning purposes and is, of course, interlocked.

The second development is primarily concerned with production and, as so often happens, is closely linked with safety; indeed, the idea occurred to the engineer of a large bakery while he was considering the design of a hopper-guard. The equipment under consideration comprised a divider chute with an open top at the level of the floor above the machine tapering downwards to a small rectangular discharge opening immediately above the divider hopper, the size of this opening being adjustable. The large mixing bowls, each containing some 400 lb. of dough, were automatically discharged into the chute, the increased head of dough resulting therefrom causing a greater rate of flow through the rectangular discharge port, which in consequence had to be reduced in area. As the level of dough in the chute fell, the rate of flow slowed down so that it then became necessary to increase the discharge opening. Since the rate of consumption of dough by the divider was constant, continuous attention was necessary to control the dough-feed. The new device boxes-in the space between the chute discharge and the divider hopper top, sheet-metal being used instead of guard bars. A duct of rectangular section rises vertically from this enclosure so that, in conjunction with the enclosure and chute, a "U-tube" effect is obtained. When a bowl of dough is discharged, the level of dough in the vertical duct rises at the same time as the dough in the chute, thereby ensuring a constant feed to the divider. The arrangement is typified by the letter "Y", the vertical leg feeding the divider while the inclined arms represent the chute and balance-duct respectively. The adoption of this device has made it unnecessary for the discharge opening to be continuously tended.

The third development concerns an ingenious hopper-feed device applied to a bun-and-roll divider which is manually fed. A stainless-steel plate is fitted in the same horizontal plane as the hopper top, one edge being secured to the lip of the hopper, the remainder of the plate extending outwards from the opening. A rectangular frame mounted in guides slides across the plate and hopper so that when the frame is over the plate it forms a drawer into which the dough is placed, but when the frame is pushed, along with the dough, towards the hopper-opening, the bottom of the drawer is left behind and the dough drops into the hopper. A grid-guard is fitted over the hopper top and this extends over the plate to the extent necessary to prevent access but without impeding the feeding of the dough into the drawer. Part of the grid-guard is removable for cleaning purposes and is therefore interlocked. The device is proving popular since it is easy to construct, simple to operate and effective both as a safeguard and as a means of feeding the machine.

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There has been a further development in the safeguarding of dough moulders. When the finished product requires the dough pieces to be fed to the longitudinal centre of the feed hopper, the provision of fencing for the sheeting rollers has always been a matter of difficulty until the method described in last year's Report was evolved. A further method has now been devised consisting of a sheet-metal "umbrella" in the form of a truncated pyramid, which is fitted permanently about 2 in. above the top of the hopper, the dimensions of the rectangular base of the pyramid being some 6 in. greater than those of the hopper. The dough pieces are passed beneath the edge of the umbrella, over the lip of the hopper and dropped into the hopper, into which it is not possible to insert the hand far enough to reach the rollers. This device is extremely straightforward to fit and is likely to be popular in view of its simplicity. Access to the rollers for cleaning can be provided by fitting the umbrella on hinges so that it can be swung clear on its supporting frame, a suitable interlock being fitted to ensure that the rollers are at rest while the umbrella is out of position.

Shipbuilding

Among safety measures initiated at a large shipyard is the welding of angle iron stanchions, through which wire ropes are passed, around openings in decks of ships under construction. This method of safeguarding these openings replaces the traditional method of staging poles and planks and also gives a far neater appearance. The wire-rope barriers have to be kept very taut and should preferably include both an upper and lower "rail". Permanent guard-rails are also fitted around decks of vessels at an early stage in their construction.

A new system of suspended shell staging has been evolved in a world-famous yard. It was brought into use because the width of the ship prevented the use of the normal uprights and thwarts. A heavy rolled-steel joist is secured to the deck and parallel sets of vertical hangers are suspended from it. The lower ends of the vertical hangers are secured to the shell plates, and steel angle-iron thwarts support platforms 3 ft. wide. In addition to the ease with which handrails and toeboards can be fitted, the stage has the advantage of being easy to erect and dismantle with the help of the shipyard cranes.

A neat hanger for use in painting ships' derricks was prepared in another yard. On certain ships the derricks are situated on the boat decks and when not in use lie horizontally at a considerable height above the hold, which may be unprotected because of the work of fitting-out the ship. Realizing the danger when moving along the derrick in the course of painting it, the foreman painter devised a hanger which can be secured to the band in the middle of the derrick boom provided for the cargo runner. The hanger is arranged to accommodate 18 in. working platforms on each side of the derrick.

Bar-reeling Machines

During the year, the Iron and Steel Federation published a report prepared by a sub-committee, on which the Department was represented, dealing with the safeguarding of bar-reeling machines. One of the sub-committee's recommendations deals with the use of automatic feeding devices. From one factory in the Midlands there is a report of the development of such a device, which has been in use on a machine for the greater part of the year, with very satisfactory results. The bar to be fed is carried forward on driven rollers and is then gripped by two revolving rolls, one above and one below the bar. These move the bar forward until it is gripped by the machine rolls. A similar device at the out-running side carries the bar into the trough, where it is

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tipped automatically ready for bundling. Only one man is required to operat the machine and all he has to do is to roll the bar down on to the first con veyor rolls and press a button. The device deals satisfactorily with badl bent bars and with those with rough ends. It was designed by the firm's ow staff, at considerable expense, but there is little doubt that the increase i production and the saving in labour costs will very quickly pay for this outlay

Textile Machinery

Good progress has been made in improving the fencing on textile machines both in the factories and on new machines supplied by the makers. As on Inspector said, "The time when guards were added as an afterthought i passing". The standard of fencing on new textile machines is greatly superio to that on similar machines made before the war.

Wool

The work of the Textile Fencing Committee continued during the year an there is no doubt that all makers of woollen machinery now realize thei obligation to provide guards in accordance with the requirements of Section 1 Such defections as there are from the full standard mainly concern the guard ing of the inner sides of gearing and arise especially in the case of guard which have to be removable. The design and construction of guards whic will provide complete enclosure and can still be lifted clear of various shaft and spindles is often a difficult matter and, consequently, close inspection c completed machines sometimes revealed unwarranted gaps. While these wer usually well below the tops of the guards and were relatively inaccessibl they often left gear intakes exposed. With these gaps, the risk is not so muc that of direct manual access, but that of a hand being dragged into dange if the loose end of a cleaning cloth should catch on the moving parts.

An exception to the above generally satisfactory position is the case c looms, in respect of which, pending conclusions reached by the Loom Fencin Committee, action has been restricted to ancillary equipment, such a jacquards and the driving arrangements therefor.

Reference was made last year to experiments in connection with inte locking panel-fencing for the side drives of garnett machines. Two types c control were considered: a time-delay bolt and a centrifugal switch, eac operated by the driving motor and controlling a solenoid-operated lockin bolt. On investigation, it was found that the former could not cater for th long period of run-down when the machine was lightly loaded; the centr fugal switch was, therefore, the only solution. The protection thus provide is of a comprehensive kind, embracing also parts which the machine-maker under no legal obligation to guard. The practical application of this con prehensive protection appeared to be prejudiced by widespread claims th such guarding, by preventing immediate access to various parts, particular to belt-drives, would seriously interfere with production. These objectio came under two main headings; first, the main side-drives from one swift t the next, as well as other side belts, are liable to be thrown off when machine is started up. This is normally dealt with either by holding the bel on by means of a stick, or by unshipping and mounting them while th machine is in motion; secondly, if a choke occurs, the belt driving the choke roller is apt to be thrown off and the practice is to stop the feed and to mak every effort to keep the machine running until it is empty, when the affecte roller can be dealt with and the machine restarted. Otherwise, since the machines cannot be started under load, a considerable amount of strippi must be done before the machine can be restarted.

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It is customary for belts to be made up by the user after a machine has been tuned and run in. The belts are fabricated from ordinary leather belting, usually with a laced joint. In many cases, the belts were found to be too slack and the joints were doubtfully parallel; it seemed possible, therefore, that a better standard of belt would eliminate many of the stoppages and would permit the machines to be started without risk of belts being thrown off. This was confirmed by trials on a machine on which the conventional belts had been replaced by narrow endless flat belts of laminated leather and plastic construction; the machine ran for three weeks without an uncovenanted stoppage and it was started up without any difficulty with all the belts in place. Belts of this construction can transmit approximately three times the load of a conventional belt of equal width. Thus a 3-in. belt replaced a double 5-in. belt, and the drives connecting the swifts on the test machine were by 1-in. belts instead of the 3-in. belts previously used. No sign of stretch was found over the period of use. The machine was employed on relatively "easy" material, but it was hoped to carry out a further trial on a machine employed on a nylon material, which is notoriously difficult. The use of this type of belt eliminates stoppages in two ways; first, there are no belt breakages due to weaknesses in the belt itself or to bad joints, and secondly, the belts are tensioned correctly and are strong enough to overcome the resistance of the usual types of chokes. Although these endless belts are more expensive than the conventional type, this would be offset to some extent, in the case of a new machine, by a reduction in the width, and hence in the cost, of the pulleys. A consequential effect of the reduction in width of the pulleys is that the corresponding reduction in the overall width of the machine, in cases where space is limited, may enable interlocked guards to be used where they could not otherwise have been accommodated.

It is hoped that the interlocking principle will be capable of being adapted to the smallest type of machines, hinged enclosures replacing the complicated close guarding, which is difficult and expensive to make and to which users have strong objections in view of the time taken to dismantle and reassemble it. One major difficulty which has yet to be overcome is the need for access to the machines for fettling, which, with the present method of working, cannot be carried out with interlocked guards in operation. There were indications that the larger textile machinery makers were attempting a measure of redesign of their machines generally, in order to attain enclosure of dangerous parts by comprehensive rather than by piecemeal guards. This is illustrated by a worsted card on which all the drives, with the exception of the chain drive to the workers, are completely enclosed. A small extraction duct at each side of the scribbler removes the little projecting fringe of wool from the web before this passes to the condenser. This of course results in a saving of material and it also reduces the amount of "fly" which collects on the machine and which the operator is constantly tempted to remove while the machine is running.

There were also modifications to gill boxes, as a result of which the side gears are enclosed by hinged double doors. Further types of gill box guards became available and one maker can provide interlock guards for both electrically-driven and belt-driven machines. The arrangement for belt-driven machines has been designed so as to have a wide range of application to machines of various makes and ages. Operational difficulties have been encountered as a result of the application of interlocked guards to some intersecting gill boxes. All gill boxes have to be turned over for certain maintenance work, such as replacing the fallers. Open gill boxes are usually of relatively light construction and can be pulled round by hand by means of the existing mechanisms, but intersecting gill boxes are much heavier machines and the

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practice in the past has been to inch them round by power. It seems likely that suitable means for turning these machines by hand will be necessary to permit interlocked guards to function correctly at all times.

Progress was made in the provision of guards for the licker-in roller on woollen cards. There does not appear to be any reason why these guards cannot extend some distance above the licker-in to cover a portion of the swift. From the safety point of view it is desirable that the top of the guard should be adjacent to a slow-running roller, e.g., the first worker, and a guard of this type automatically prevents access to the intake between the swift and the fast-running first stripper.

The woollen industry covers a wide range of products and a correspondingly wide range of processes, and the operational technique of a basic type of machine may vary considerably according to the final product and also according to its function in the processing sequence. In all old-established industries there is considerable reluctance to accept new forms of guarding which may involve changes in long-standing practices, or which may obscure mechanisms and operating parts which have been visible and accessible from time immemorial; the woollen industry is no exception.

The Wool Technical Committee has the duty of enquiring into methods of fencing and the adoption of other safeguards for certain parts of dangerous machines and the Joint Factory Advisory Committee of the Wool Textile Industry suggested that the Committee should work in consultation with the machinery makers. This line has been followed with considerable success in obtaining compliance with Section 17. The position in respect of other dangerous parts is, however, very different, and it appears that much wider liaison within the trade will be necessary if any significant progress is to be made in attaining higher general standards of fencing. There is plenty of scope for improving the standards of fencing provided by the occupiers for old machines.

Preliminary discussions took place with the Wool (and Allied) Textile Employers' Council with the object of expediting the development and adoption by the trade generally of guards for parts of machines which experience has shown to be dangerous. The proposals include making available technical advice on safeguarding to the various sections of the trade; obtaining facilities for testing and developing guards; and co-operation in the adoption and installation of guards.

The new autoleveller is growing in popularity and this makes a contribution both directly and indirectly to safety in the drawing section of worsted spinning, for the autoleveller is not only well guarded in itself but it replaces several machines which were the cause of accidents, including gill boxes and drawing boxes. The steady increase in the number of automatic teasing plants is enabling much better fencing to be provided at fearnoughts and other opening machines. It simplifies the problem of fencing feed-rollers, because when the feed is controlled at a steady rate the necessity for access to feed-rollers in the event of a choke is almost entirely eliminated. This makes fencing practicable.

The principle of the tunnel-guard or the automatic knock-off guard for the rollers of rag-grinders has been accepted, but progress in fitting guards was still slow. New machines are being fitted with a trip-guard which reverses the rollers.

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Lace

In the lace finishing trade, attention was given to the guarding of dipping rollers. These machines consist of a pair of heavy rollers which are mounted similarly to those of the old-fashioned household mangle but are considerably larger and heavier and are power-driven. Lace in rope form, after travelling through a sizing solution, is passed between the rollers. Accidents, though rare, have been serious. There has always been considerable resistance to guarding these machines. The objections raised have always been that lace is a very fragile fabric and therefore additional tension must not be applied to it. One or two firms have succeeded in using guards for some years and, following an accident, another firm fitted one. Photographs of this guard were shown in a number of factories and this resulted in several more firms adopting the guard. It is quite simple, consisting of a free-running wooden roller mounted in front of the upper driven-roller and approximately level with its upper surface. From this a sloping bar is fitted which, in addition to being a guard, helps to guide the lace into the nip. The mounting height of the free-running roller and the space between it and the upper driven-roller are the important factors, as sufficient space must be allowed for the rope of lace to pass, but the space and the mounting height must be such that a hand cannot reach the nip.

Jute

There were no outstanding developments in the design of jute machinery during the year. Work continued on improving the standard of fencing and, in particular, in endeavouring to attain the types of guards specified in the Regulations. Among the matters finalized was the satisfactory interlocking of the fully detachable cover for the end gears of the spinning frame produced by one of the principal machinery makers. This was accomplished by the use of a magnetic limit-switch working in conjunction with a captive locking bolt to cover the run-down period. Two makers devised methods of protecting the nip between the pressing roller and delivery roller on carding machines, although, not long before, the problem had been thought to be insuperable. Both devices were tried out by various users during the year and no objections were raised to their use. The provision of protection for the same parts in the case of finisher cards presents a more difficult problem; nevertheless, all the machines made by one firm are provided with guards which are reasonably satisfactory.

CHAPTER 2

Accidents—General Observations

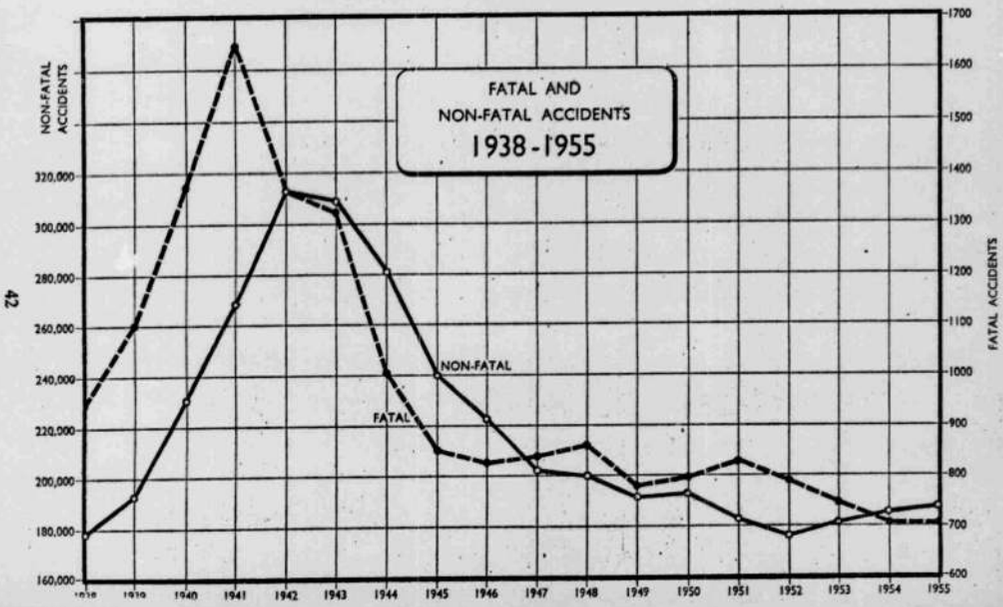
DURING the year under review, 188,403 accidents were reported from all premises within the purview of the Factories Acts. The corresponding figure for 1954 was 185,167. Since 1952, for which year the figure was the lowest recorded since the war, there has been a steady increase in the number of accidents reported, but during the period 1952-1955 there was a steady overall increase in industrial activity, which was undoubtedly the major factor in producing the increased number of accidents. Fig. 1 shows the fatal and non-fatal accidents reported from all premises since 1938.

Fatal Accidents

During 1955, there were 703 fatalities in all premises subject to the statutory requirement to notify accidents to the Inspectorate. Fig. 1 shows that there

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FATAL AND NON-FATAL ACCIDENTS, 1938-1955.



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has been a decrease in the number of continuous fatalities since 1951, when the corresponding figure was 828. The greater part of this decrease took place in factories, the fatalities in which decreased from 511 in 1951 to 428 in 1955, corresponding to rates of 70 and 55 per million workers respectively. This significant decrease should be a real encouragement to all concerned with both accident prevention and the treatment of the injured.

The number of fatalities at building operations, works of engineering construction and docks, etc., has, during this period, tended to decrease rather than to increase, but progress is not so evident as in the case of factories. Furthermore, although accurate figures for the labour force subject to these special extensions of the Factories Acts are not readily available, it is known that the fatality rate for the non-factory premises is considerably higher than that for factories only; I therefore look to the industries concerned to match the decrease in fatalities which has been achieved in factories.

Accidents in Factories

Of the total of 188,403 accidents reported in 1955, 163,332 were in factories. This figure shows an increase over the previous year's figure of 161,458.

In recent years it has become obvious that the year-to-year changes in accident rate, i.e., in the number of accidents per 1,000 workers, have been relatively slight compared with the considerable changes which took place during the war and immediate post-war years. This year, therefore, I have tried to express the accident rate in such a way that year-to-year changes can be given more accurately than hitherto. The number of accidents reported is accurately known, but it is not so easy to obtain an accurate estimate of the number of employed persons subject to the Factories Acts (the "factory population"). The estimate actually used is obtained, broadly speaking, as follows. For the years 1952, 1953 and 1954 the numbers of persons subject to the Factories Acts at the end of December, as recorded in District Offices, were totalled and the national figure obtained. This figure suffers from the disadvantage that it is compiled from information obtained by Inspectors at visits to factories and is therefore subject to an indeterminate time-lag. The only other figure available is that of the number of persons employed in the "Manufacturing Industries" of the Standard Industrial Classification. This number includes non-manual workers and others not subject to the Factories Acts. Furthermore, many workplaces subject to the Factories Acts are not included in the "Manufacturing Industries" — for instance, many retail or wholesale distributing establishments contain portions subject to the Factories Acts. Thus neither of the two figures available is by itself satisfactory, and both must be used to arrive at the best estimate available in the circumstances. The procedure which has been adopted hitherto is to take a ratio obtained some time ago between the Factory Department figure and the total in the manufacturing industries and to apply this ratio in successive years to the total in the manufacturing industries. (In addition, correction was made for persons absent because of sickness.) This ratio has now been brought up to date by means of the Factory Department figures obtained in 1952-54, and the correction for sick absence has been abandoned. On this basis, the estimate for 1955 for the factory population is 7,800 thousands, and for this estimate it is impossible to claim an accuracy of more than the nearest 100 thousand, because of the uncertainty involved in the value of the ratio. The total number employed in the manufacturing industries is, however, obtainable from year to year to a higher degree of accuracy, therefore the year-to-year *changes* in the estimated factory population can be obtained with a higher degree of accuracy than can the actual number.

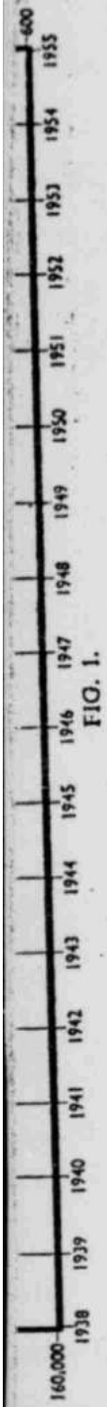


FIG. 1.

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In these circumstances, the accident rate can be expressed in the form of an index number in order to show the year-to-year changes. This has now been done, taking the accident rate for 1950 as 100. The actual value of the rate in 1950 was, on the present basis, between 23 and 24 per 1,000, and in 1955 is about 21 per 1,000. These figures are slightly lower than would have been obtained on the basis of the estimates for the factory population used in previous Reports, chiefly because the correction previously applied for persons absent through sickness has now been omitted. To summarize, the estimated factory population is simply the total number of persons in factories who are subject to the Factories Acts; persons temporarily or permanently unemployed are excluded, but persons absent through sickness, holidays, etc., are included; the figure is the average for the calendar year.

Table 3 shows the accident rate index from 1949 to 1955 for persons of all ages and both sexes and also the corresponding indices for men, women, boys and girls for 1950-1955. In the latter cases the figures for 1949 were not readily available; 1950 has therefore been taken as the reference year in all cases. For the sake of record, it should be stated that for men, women, boys and girls the employment figures are not the annual averages, but the figures for the end of May in each year, the annual averages not being obtainable; there is reason, however, to believe that the differences between the two sets of figures are unimportant for the present purpose.

TABLE 3

INDICES OF ACCIDENT RATES (FACTORIES ONLY)

	Total Accidents	Index (1950 = 100)
	All Persons	
1949	172,026	103·7
1950	170,371	100·0
1951	161,420	92·8
1952	155,466	90·1
1953	158,597	90·9
1954	161,458	90·3
1955	163,332	89·2
	Adult Males	
1950	135,869	100·0
1951	127,709	92·5
1952	123,774	89·0
1953	125,853	90·0
1954	127,057	89·0
1955	128,464	87·5
	Adult Females	
1950	22,387	100·0
1951	21,731	92·9
1952	19,929	88·2
1953	20,773	90·9
1954	22,047	93·4
1955	22,726	93·4
	Boys	
1950	8,840	100·0
1951	8,756	98·5
1952	8,605	96·1
1953	8,625	96·4
1954	8,892	97·3
1955	8,754	96·3
	Girls	
1950	3,275	100·0
1951	3,224	98·4
1952	3,158	97·8
1953	3,346	102·5
1954	3,462	103·9
1955	3,388	100·9

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The index for all persons (see Fig. 2) shows a general and substantial decrease over the period 1949-1955. This decrease is less rapid in the more recent years, but the rate in 1955 is the lowest yet recorded.

Analysis by Age and Sex

In 1955, the accident rate for adult males was about 26 per 1,000 and for women about 10 per 1,000; the rates for boys and girls were about the same as the rates for men and women respectively. The corresponding indices are shown in Fig. 2. The index for men is, of course, the preponderating factor in the "all persons" index, and therefore shows the same general trend, namely a general decrease, apart from a slight increase in 1953 following a lower value in 1952. This low value and subsequent increase is no doubt largely attributable to the trade recession of 1952 with its accompaniment of less overtime and more short-time working. There was, however, throughout the whole period a steady increase in the total number of men at work in other words, more were entering industry than were leaving. Also, production was steadily increasing except in 1952. In these circumstances I consider that a reduction in accident rate over the period indicates real progress in accident prevention.

The index for boys is not so encouraging; it shows far less downward movement over the period 1950-55 than that for men. In 1954 there was a relatively heavy intake of boys into industry, followed in 1955 by a slight decrease in the total number. Possibly the arrival of many newcomers into the factories in 1954 may have been the cause of the slight increase in accident rate for that year; the position has been restored by a slight decrease in accident rate in 1955. I can only hope that 1956 will continue this downward movement, but progress is much too slow, especially when it is remembered that the accident rate for boys is not less than that for adult males.

The accident rate indices for women and girls show an entirely different picture, which can only be described as one of considerable fluctuation. As far as women are concerned, a major reason for the 1952 drop and subsequent increase in accident rate is, of course, the 1952 recession in the textile industry. Many of the workers recorded as employed were by no means fully employed, therefore the 1952 accident rate is considered to be unduly low. Also, such a recession drives the less productive workers, who are presumably less skilful and more liable to accident, out of employment, while a recovery brings them back, or brings back other completely "green" labour in their place, with a consequent increase in accident rate. Since 1953, however, the increase in the women's accident rate cannot be ascribed to any one industry, but to the general increase in the numbers of women in employment. This increase must consist largely of "green" labour. The best that can be said about the accident rate for women in 1955 is that, considering the considerable and steady increase since 1952 in the number employed, it would not have been surprising if the 1955 rate had exceeded that for 1954 instead of equalling it.

As far as the girls are concerned, there has been a steady increase in the numbers employed since 1952. In 1953 there was a rise in the accident rate followed by a further rise in 1954 and an appreciable drop in 1955. Here, again, a labour intake seems associated with a rise in accident rate, with the exception of 1955 when the drop in accident rate took place despite a slight increase in numbers employed.

I have emphasized repeatedly in these Reports that accident prevention, in the case of young persons, is the problem of "green" labour and that

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INDICES OF ACCIDENT RATES: AGE AND SEX.

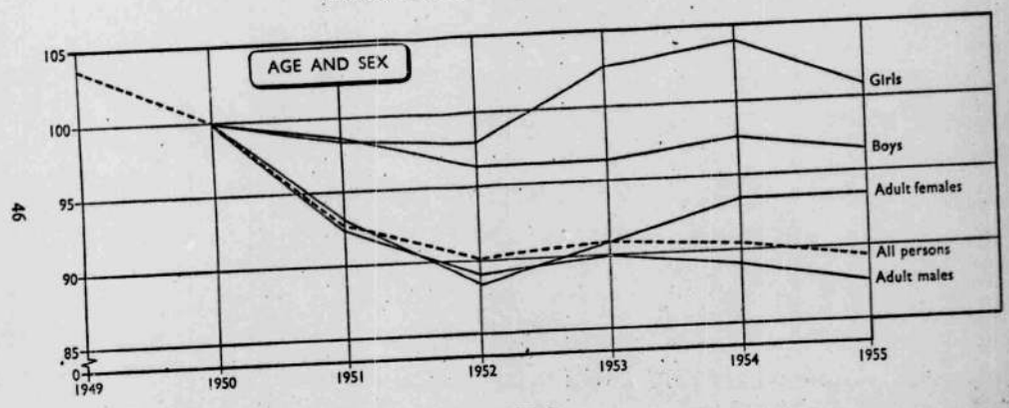


FIG. 2.

INDICES OF ACCIDENT RATES: CAUSATIONS.

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INDICES OF ACCIDENT RATES: CAUSATIONS.

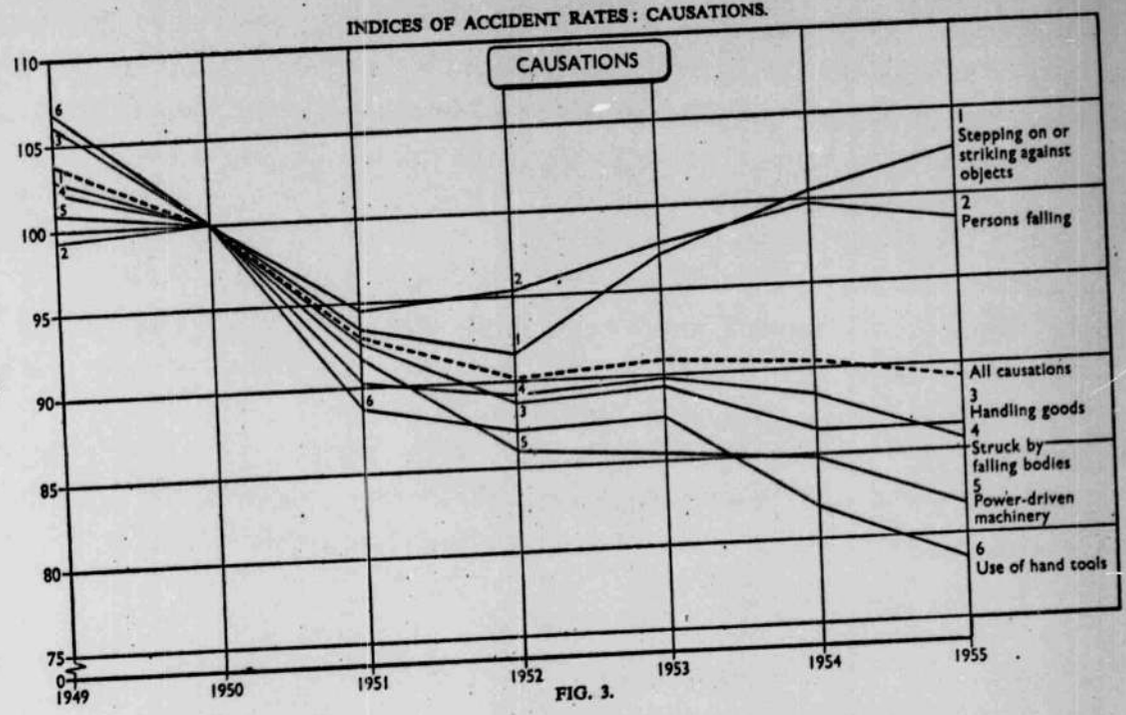


FIG. 3.

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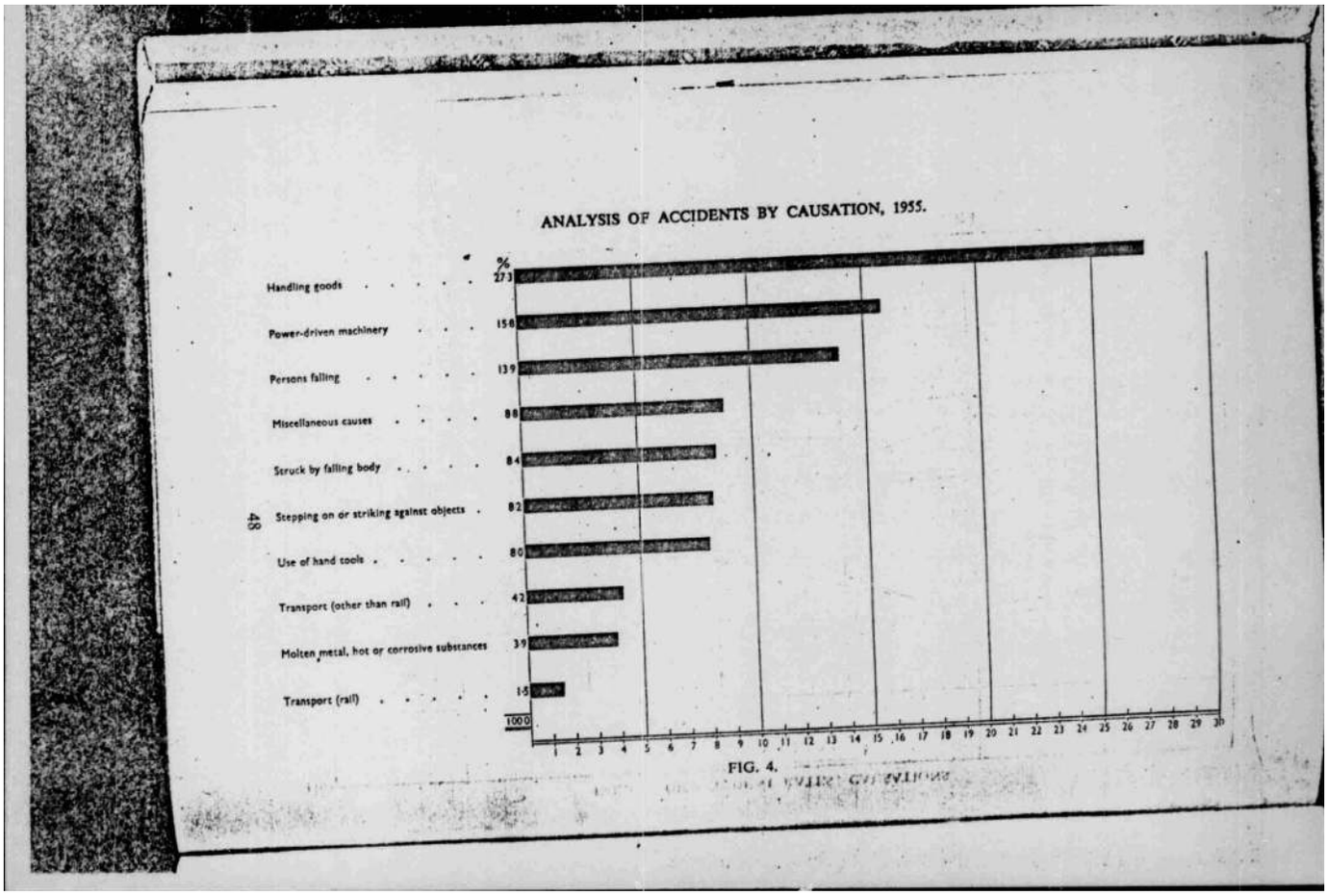


FIG. 4.

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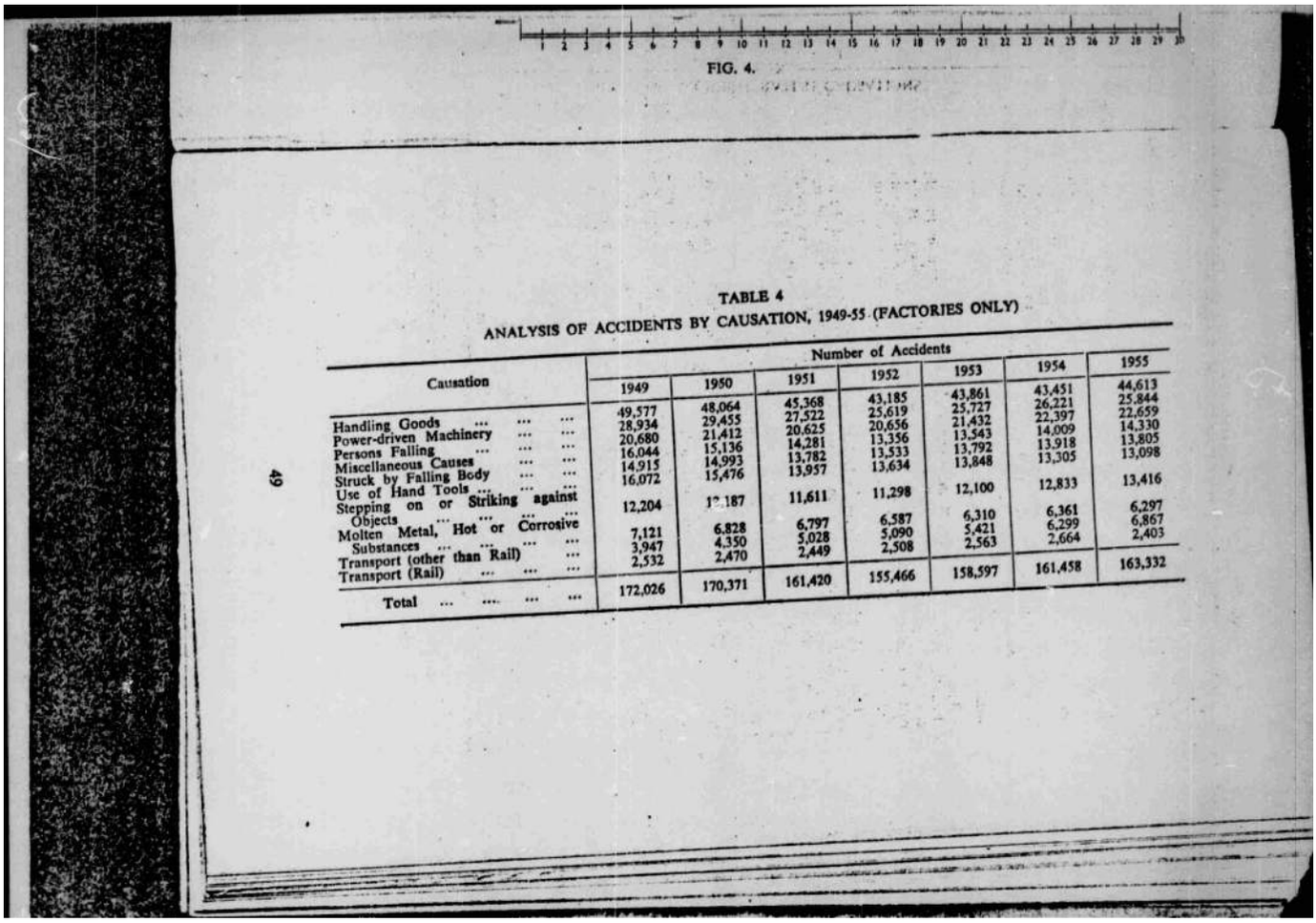


FIG. 4.

TABLE 4

ANALYSIS OF ACCIDENTS BY CAUSATION, 1949-55 (FACTORIES ONLY)

Causation	Number of Accidents						
	1949	1950	1951	1952	1953	1954	1955
Handling Goods	49,577	48,064	45,368	43,185	43,861	43,451	44,613
Power-driven Machinery	28,934	29,455	27,522	25,619	25,727	26,221	25,844
Persons Falling	20,680	21,412	20,625	20,656	21,432	22,397	22,659
Miscellaneous Causes	16,044	15,136	14,281	13,356	13,543	14,009	14,330
Struck by Falling Body	14,915	14,993	13,782	13,533	13,792	13,918	13,805
Use of Hand Tools	16,072	15,476	13,957	13,634	13,848	13,305	13,098
Stepping on or Striking against Objects	12,204	12,187	11,611	11,298	12,100	12,833	13,416
Molten Metal, Hot or Corrosive Substances	7,121	6,828	6,797	6,587	6,310	6,361	6,297
Transport (other than Rail) ...	3,947	4,350	5,028	5,090	5,421	6,299	6,867
Transport (Rail)	2,532	2,470	2,449	2,508	2,563	2,664	2,403
Total	172,026	170,371	161,420	155,466	158,597	161,458	163,332

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however good the general factory conditions may be there is no substitute for proper induction, training and supervision. If young persons are transplanted from a relatively sheltered existence into industrial employment without proper precautions being taken against their inexperience, inquisitiveness or possible propensities to mischief, accidents must inevitably happen for which their seniors are morally and possibly legally responsible.

Accident prevention, as far as adult women are concerned, is also more a problem of "green labour" than is often realized. I should like managements to ask themselves what they are doing to protect the ex-housewife, shop or office worker who finds herself for the first time in a factory against the consequences of her complete unfamiliarity with her environment. In many cases, it would appear to be no one's business to explain to her the very ABC of taking care of herself by means of safe methods of working and the wearing of suitable clothing.

Analysis of Accidents by Causation

The relative importance of the various causations is shown in the chart (Fig. 4). The number of accidents due to each causation is shown as a percentage of the total accidents for the year. The broad outline of the causation pattern continues unchanged from year to year, but there are some changes of interest.

Table 4 shows the causation analysis from 1949-1955, in terms of the total number of accidents due to each. Table 5 gives each of the more important causations in terms of the number of accidents per 1,000 of the factory population, the resulting rate being expressed in index form (1950=100). The indices are shown in Fig. 3.

Handling Goods

This, as the most important causation, follows, as might be expected, the general trend of the total, with a decrease over the period, except for 1953 and for the year under review. It is a little disappointing that the accident rate due to this causation has not again decreased this year: it was hoped that the ever-increasing introduction of mechanical handling would effect further reductions, but there are hints from reports that some man-handling in connection with mechanical handling may be partly responsible; mechanical handling is not always as well thought out as it might be in relation to the process as a whole and sometimes involves unnecessary or awkward incidental man-handling.

Power-driven Machinery

The index shows steady progress, which persisted in 1955. No one would claim that the number and complexity of power-driven machines in industry is decreasing, but rather the contrary. The progress achieved cannot, I think, be taken as anything other than a consequence of the considerable effort which has been expended on the safeguarding of this machinery by all concerned, but as this causation is still second in relative importance, there is room for much further improvement.

Hand Tools

The index shows the steepest decrease of any; this decrease, which persisted in 1955, no doubt reflects the continuing displacement of hand tools by portable powered tools.

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TABLE 5

INDICES OF ACCIDENT RATES FOR VARIOUS CAUSATIONS
(FACTORIES ONLY)

Causations	1949	1950	1951	1952	1953	1954	1955
All Causations ...	103·7	100·0	92·8	90·1	90·9	90·3	89·2
Handling Goods ...	106·0	100·0	92·5	88·7	89·2	86·2	86·3
Struck by Falling Body	102·2	100·0	90·1	89·1	89·9	88·5	85·7
Power-driven Machinery ...	100·9	100·0	91·5	85·9	85·3	84·8	81·6
Use of Hand Tools	106·7	100·0	88·4	87·0	87·4	81·9	78·7
Persons Falling ...	99·2	100·0	94·4	95·3	97·8	99·7	98·4
Stepping on or Striking against Objects	102·9	100·0	93·3	91·5	97·0	100·4	102·4

Struck by Falling Body

This causation follows the general trend, the index showing a decrease in 1955. This causation is, of course, allied to "Handling Goods", in that a substantial proportion of accidents occur incidentally to handling processes; furthermore it is not always possible, on the basis of information supplied on accident report forms, to decide with certainty in which of the two causations to classify some accidents.

Stepping on or Striking against Objects and Persons Falling

These two causations are again allied, in so far as a large proportion of falls take place "on the flat" rather than from heights, and many of these are caused by stepping on or striking against objects. It is again not always possible to classify accidents with certainty into one or other of these two causations, and many classed as "falls" might well, if complete information were available, be put into the other causation.

The interesting thing about this pair of causations is that, while before 1952 they followed the general decreasing trend, since then they have substantially increased. If taken together, these two causations are second only in importance to "handling goods", therefore we really have here a problem to tackle urgently. A major reason for the increase in these two causations is, no doubt, the increasing volume of production and consequent increasing congestion of factory space. Obviously, the more goods, articles and persons there are on a given floor space, the more chance there is of stepping on or striking against objects, with consequent injury. I am well aware of the cost, and in some areas, the scarcity of factory space, and that it would be a counsel of perfection to urge every congested factory to expand or to move into more commodious premises; nevertheless, in many apparently hopelessly congested premises space can be better utilized by works planning and by the imaginative use of storage devices. Even in factories where lack of space is not an acute problem, there is plenty of evidence of poor housekeeping and general lack of tidiness. I am aware that I am not stating anything new in stressing the importance of order and tidiness, but I have no hesitation in putting it as "Number One" on the list of priorities in accident prevention.

Transport

These accidents are discussed in Chapter 5 and it is sufficient to say here that non-rail transport is the only other of the main causations to show an increasing trend. It is, relatively, not one of the most important, but the rate of increase is, in comparison with that of the others, enormous. The actual number of accidents per year has more than doubled since 1948.

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TABLE 6

ACCIDENTS CAUSED BY POWER-DRIVEN MACHINERY, 1949-1955 (FACTORIES ONLY)

Causation	1949	1950	1951	1952	1953	1954	1955
Prime Movers	121	155	183	207	154	159	185
Shafting	97	85	75	70	80	79	51
Belts, Ropes, Pulleys	679	620	569	549	547	563	531
Lifting Machinery	3,159	3,279	3,170	3,059	3,132	3,187	3,244
Milling Machines	380	399	357	335	330	335	351
Power Presses	528	562	548	457	418	490	502
Circular Saws	1,923	1,972	1,904	1,652	1,554	1,536	1,509
Planing Machines	966	953	939	934	874	911	900
Vertical Spindle Moulding Machines	331	356	345	288	336	310	295
Other Woodworking Machines	732	795	714	701	704	634	648
Rollers of Calenders, Mixers, etc.	621	652	656	618	659	782	806
Unclassified	19,397	19,626	18,062	16,749	16,939	17,235	16,822
TOTAL	28,934	29,455	27,522	25,619	25,727	26,221	25,844

Power-driven Machinery

Table 6 brings up to date the usual analysis of power-driven machinery accidents.

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machinery

Frequency Rates

Table 7 gives the accident frequency rates for 1955 for various industry groups and also the figure for all industries. These rates are compiled from information sent in, on a voluntary basis, by no fewer than 2,748 individual factories which keep records of the number of accidents causing disablement beyond the day (or shift) of the occurrence. The number of these accidents, multiplied by 100,000, is divided by the total number of man-hours worked in the factory during the calendar year, the quotient being defined as the "International Accident Frequency Rate". I am most grateful to all those firms who co-operate in supplying this information.

It will be noted that this year's rates are, in aggregate and also in most individual industry groups, somewhat higher than the corresponding figures for 1954. The reason for this is that, as mentioned in my Report for 1954, many firms had inadvertently been supplying information based only on the number of accidents statutorily notifiable, i.e., those involving more than three days' disablement. In 1955, therefore, a new form of return was sent out on which it was made clear exactly which of the two classes of accident was asked for; the response made it quite clear that in some cases only reportable accidents had previously been included. Thus the figures for 1954 and previous years must be considered as unduly low.

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TABLE 7
ACCIDENT FREQUENCY RATES

Industry Group	Number of Firms	Numbers Employed	Frequency Rate
(1)	(2)	(3)	(4)
TEXTILES	224	147,452	1·29
Cotton	73	44,116	1·54
Wool, Worsted and Shoddy	81	45,079	1·11
Flax, Hemp and Jute	18	12,036	2·22
Silk, Rayon, etc.	30	28,704	1·09
Hosiery	9	8,376	0·58
Other Textiles	13	9,141	1·12
CLAY, STONE, LIME AND CEMENT	108	26,451	2·11
Brick, Pipe and Tile-making	60	14,921	2·36
Other Clay, Stone, Lime and Cement	48	11,530	1·78
METALS	306	298,894	2·79
Iron and Steel Manufacture: extraction, conversion, rolling and tubes	130	175,339	2·77
Iron and Steel Founding	87	43,582	3·20
Tinplate	21	18,882	3·40
Steel Wire and Wire Rope	9	5,920	3·26
Non-Ferrous Metal Extraction, Conversion, Refining and Founding, Rolling and Tubes	59	55,171	2·29
ENGINEERING WORKS (OTHER THAN MACHINE MAKING)	487	440,486	1·53
Marine Engine-building and Repairing	138	84,375	2·12
Locomotive-building and Repairing	10	13,324	2·49
Other Engine - building, Transmission Machinery	47	57,575	1·12
Boiler-making	15	15,769	2·14
Constructional Engineering	32	16,244	2·99
Electrical Engineering	178	207,739	1·15
Hydraulic, Ventilating and Pneumatic Engineering	24	21,674	1·85
Machine-tool and other Tool-making	43	23,786	1·25
MACHINERY, MACHINERY ACCESSORIES, ETC.	331	369,887	1·54
Textile Machinery and Accessories	12	11,934	1·68
Other Miscellaneous Machine-making	60	58,525	1·49
General and Jobbing Engineering, Making and Repairing Machinery	125	80,901	1·76
Railway and Tramway Plant and Vehicles	11	16,015	2·33
Motor Vehicles (other than steam), Motor Cycles, Cycles, Carts and Carriages	91	157,107	1·26
Ordnance and Munitions of War	32	45,405	1·88
LIGHT METAL TRADES	84	56,102	1·52
INDUSTRIAL APPLIANCES (Locks, Bolts, Screws, Springs, Chains, etc.)	28	151,706	1·70
MISCELLANEOUS METAL TRADES	30	22,291	1·62
SHIPBUILDING	65	104,790	2·43
AIRCRAFT	55	98,461	0·80
GENERAL WOODWORK	48	16,142	1·95
Saw Mills, Joinery and General Woodworking	26	7,120	2·55
Box and Packing Case Making	3	571	3·98
Brushes and other Special Woodware	7	2,658	1·20
Other Builders' Materials	12	5,793	1·35
FURNITURE, ETC.	34	21,674	1·98
Cabinet and Chair Making, Upholstery	12	3,534	1·26
Other Furniture Making	22	18,140	2·11

(Table continued on next page)

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Industry Group	Number of Firms	Numbers Employed	Frequency Rate
(1)	(2)	(3)	(4)
Pottery	21	14,806	1·27
Glass	24	19,581	2·25
Chemicals, etc.	156	113,735	1·43
Artificial Manure	5	1,436	1·80
Coal Tar	20	5,407	3·35
Other Chemicals	114	101,443	1·29
Paints, Colours and Varnish	17	5,449	1·88
Tanning, Currying Leather	16	4,374	1·66
Printing, Bleaching, Dyeing and Cleaning	39	13,872	1·05
Textile Printing, Bleaching and Dyeing	15	6,251	1·22
Cloth Finishing, Raising, Lapping, Making-up and Packing	–	—	—
Job Dyeing, Other Finishing, Cleaning and Dyeing	4	1,831	1·00
Laundries	20	5,790	0·85
Wearing Apparel and Articles for Personal Use	91	46,716	0·61
Tailoring	14	8,998	0·74
Dress, Millinery, Underclothing and Other Wearing Apparel	30	14,621	0·61
Boots, Shoes, Slippers and Clogs	47	23,097	0·56
Rubber Trades	41	54,355	1·23
Paper, Printing and Stationery	180	113,952	1·50
Paper, Cardboard and Millboard-making	74	41,015	2·37
Letterpress and Lithographic Printing and Bookbinding	75	56,558	0·82
Cardboard and Paper Box-making	22	9,124	1·63
Other Printing, Photography, etc.	9	7,255	1·27
Food	142	118,771	1·96
Flour and Other Milling	10	3,371	2·08
Bakeries	31	29,357	1·64
Confectionery (Sugar), Groceries, etc.	27	38,455	1·58
Other Foods	74	47,038	2·41
Drink	34	12,897	2·89
Alcoholic	32	12,076	2·92
Non-Alcoholic	2	821	2·50
Tobacco and Matches	20	25,940	1·12
Oilcake, Oil Refining and Extracting	24	20,997	2·21
Soap, Starch, Candles, etc.	16	14,584	1·34
Fine Instruments, Jewellery, Sports Articles, etc.	62	42,587	1·16
Gas Works	36	17,280	2·48
Electrical Stations*	11	34,145	2·30
Other Miscellaneous Industries	12	5,918	1·65
Places under Sections 105-108 of the Factories Act, 1937	23	16,764	2·27
Docks	–	—	—
Building Operations (Construction, Maintenance, Demolition)	21	13,113	2·22
Works of Engineering Construction	–	—	—
Warehouses	2	3,651	2·50
Grand Total	2,748	2,445,060	1·73

* The figures refer to the 11 Generating Divisions of the Central Electricity Authority, not to the actual generating stations.

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CHAPTER 3

Accident Prevention Organization

TIME and again, it has been emphasized by everyone dealing with the subject of accident prevention that, unless a genuine and continuing interest is shown by top management, the scheme, however excellent on paper, is doomed to stagnation and ultimate failure.

A personnel manager admitted to one Inspector that there was supposed to be a safety committee in his firm but that he as chairman had not called it since he took over the job of personnel manager nine months ago. In fact, the committee had not met for about a year. Committees should not be allowed to lapse any more than such things as the production of weekly output figures. If the management in this firm had had a real interest in the matter such a lapse could not have occurred, especially when a new person took over the job of chairman.

If there is a falling-off in the standards of an accident prevention organization it is not necessarily due to lack of goodwill at the top. For example, the safety organization in one large firm centred round a safety department of 10 men and some 300 co-opted safety inspectors, and a works safety committee which met monthly, but the director, who was primarily responsible for these arrangements, had become very hard-pressed with other duties. Certain accidents occurred which indicated that reorganization was desirable. This firm, on looking into matters, then made the following improvements: the general works manager was given a measure of direct responsibility for safety; supervisors' personal records, which counted for promotion, were extended to take accident figures into account; a safety committee was formed in each main department, with the departmental superintendent as chairman, other members being the co-opted safety inspectors and either the head of the safety department or one of his staff, and the staff of the guard-making shop was doubled. The effect of all this was said to be that "Men in the departments ask for guards and pursue the matter until these are provided and then do the fitting themselves instead of waiting for someone else to do it".

Some firms seem to have a strange idea of the proper functions of a safety officer. In one very large establishment, there is one safety officer (with little or no training for the work) who spends much of his time in making reports on claims at Common Law by injured persons. While the making of such reports is a duty which is discharged by many safety officers as a regular part of their job, nevertheless it is not their main function, which is accident prevention. A good safety officer should try to get the confidence of all ranks as an impartial technical adviser on safety: there is a good deal to be said, at any rate in a large establishment, for having reports on accident claims compiled by the usual managerial machinery, and minuted by the safety officer as a technical expert.

The status of the safety officer must be such as to enable prompt action to be taken on his advice. In one firm, two power presses were installed and put into operation with guards which were obviously inadequate, despite the

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protests of the safety officer and in spite of the fact that this firm is of considerable repute for interest in safety matters.

Another point which emerges from Inspectors' reports is that the peripatetic safety officer working from the headquarters of a widely scattered establishment can do little unless there is in addition a responsible officer at each large unit of a group.

One Inspector, commenting on the value of accident prevention organizations, says: "This District is extremely fortunate in possessing a relatively large number of organizations which do excellent work in the accident prevention field. It is no exaggeration to say that without their efforts there would have been an alarming increase in accident frequency rates for the District". He continues: "Most of the important factories have accident prevention committees which have been long established. One such factory commenced its accident prevention activities in the early 1920's and the present organization is probably the finest of its type in the country today. Every accident, however trivial, is thoroughly investigated and appropriate action is promptly taken to prevent any repetition. Blame is attributed in a very impartial manner and there is no respect for the status of the individual concerned. Disciplinary action is taken where necessary without fear or favour and the firm receives the wholehearted support of the Union secretaries and shop stewards in its action. Frequency rates of less than unity are general. No efforts are spared to maintain interest in the work and the incentives are financial and social. Inter-works competitions are annual events which cost a great deal of money. The knowledge of the competing teams both of first aid and of accident prevention is remarkably good. Such competitions are always a tremendous success since valuable prizes are awarded. Only after many years of work and after two generations of workers has this degree of efficiency been attained. The Factory Department owes the firm a debt of gratitude for its co-operation and unsparing efforts towards the general cause of accident prevention."

The good work done by the accident prevention organization at a big iron and steel works is commented on by the District Inspector: "The works has continued an excellent record by maintaining a substantial reduction in accident frequency rate for the seventh year in succession:

Year	*1948*	*1949*	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*
Average number of employees	3,160	3,200	3,450	3,520	3,766	3,911	3,830	3,929
Number of Lost Time Accidents ...	254	222	209	184	169	147	133	116
Frequency Rate ...	3·19	2·77	2·49	2·18	1·80	1·56	1·43	1·20

During the period concerned, while the number of employees has increased, the number of lost-time accidents per year has decreased from 254 to 116. The number of man-hours lost per year has been reduced from 50,312 to 20,720. Outstanding success has been achieved at this works in the reduction of accidents with rail traffic and rolling stock. In 1948 there were 44 lost-time accidents, many of which were serious. During 1955 there were only 7, all of which were of a minor nature."

Since the appointment in 1954 of a safety officer, the monthly total of treatment for injuries in an aircraft factory was cut down from just over 400 to 250. There were, in 1955, only four reportable accidents, which is a fine record for a factory employing 2,000 people. In a large engineering works,

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in addition to the activities of a full-time safety officer, supervision generally is made to play a big part in safety work. Senior supervisors are kept fully aware of their responsibilities; Factory Department and R.O.S.P.A. publications are brought to their notice, and they take part in discussions on accidents and on the provision of further aids to safety. During 1955, many of them attended three-week courses organized by the Engineering and Allied Employers' West of England Association; a talk by an Inspector, followed by discussion, was included in the agenda of each course. This firm has had a continuous fall in its accident rate over a period of six years.

Of one large engineering firm the Inspector reports: "This firm held a 'Ten Years of Safety' week in May, 1955, with exhibitions, films and competitions in safety. It was ten years ago that the safety department was set up to deal with the high incidence of accidents. There has been a remarkable drop in the number of reportable accidents, from 424 in 1945 to 195 in 1955. Numbers employed rose from 5,560 to 5,854 during that period. Man-hours lost dropped from 160,185 in 1945 to 60,230 in 1955. The corresponding frequency rates were 3·54 and 1·54. The safety department of the firm rightly claims some of the credit."

The importance of preventive maintenance has been repeatedly stressed and can hardly be over-emphasized. A mechanized foundry, at which the works engineer is the safety officer and where the directors take a keen interest in safety, introduced a system of preventive maintenance. All buildings, plant and machinery are examined regularly by members of the maintenance section, who complete and return to the engineer a form containing particulars laid down by him. A few of the matters which receive weekly attention as to condition are fire-fighting appliances, roofs, ladders, and all dust extraction plant. In much the same way, planned systems for the inspection and maintenance of automatic safety devices in card-rooms and blowing rooms of cotton mills are resulting in a higher standard of compliance with safety requirements.

At a chemical works, one of the matters which has had attention during the year was the system of handing over plant from supervisors to fitters and *vice versa*, because it was found that that was when some of the mishaps occurred. The proper use of "permit-to-work" systems, as stressed in my Report for 1954, can play an important part in reducing accidents at these stages.

At the same chemical works, useful suggestions for safety sometimes come from the medical officer, who examines all employees at frequent intervals, as there is a considerable health risk. The men tend to talk to him and to suggest improvements. The firm has also put on an attractive display of gloves, boots, goggles and respirators in a corridor near the washing facilities. A container which exploded was put in the display-case to warn the men against putting anything inflammable near a source of heat.

An unusual development in safety work was the formation in a vegetable preserving factory of a night accident prevention committee. Some 500 night-shift workers felt that conditions at night, when a great deal of cleaning and process work was done, were not receiving adequate consideration by the existing safety committee. Consequently the night committee was formed and functions separately.

At a large food factory, in order to identify the safety representatives, and to encourage workers to discuss hazards with them, each representative was provided with a button-hole or brooch badge, specially designed. The

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privilege of displaying these badges is all the more appreciated because works rules prohibit the wearing of anything in the nature of jewellery owing to the risk that it may fall into the products. The "safety" badges have had to be designed with special clips, on this account. A steelworks has adopted the same method of identifying all the members of its main and departmental safety committees, and has found the "badge of office" warmly welcomed by the men concerned.

Inspectors report on the increased use of safety footwear. At one large engineering works a free issue of safety boots is made to all employees in the foundry and as a consequence the incidence of foot injuries has been very low. Where arrangements are made merely to enable the workers to purchase safety boots the response may not be immediate but the wisdom of persevering with a scheme is shown by the experience of one firm. Early in the year, the works manager tried to interest the men in a hire-purchase scheme for safety boots; at first, the men were suspicious of the management's motives, and only half-a-dozen entered the scheme. In the autumn, however, there was a sudden demand for safety boots and this has persisted. The explanation advanced by the works manager is that the men at last realize that the management are not getting anything out of the sale.

Safety footwear is now available with resin-based synthetic rubber soles which are resistant to both heat and oil. Hitherto there has been one variety of footwear to resist heat and another to resist oil, but the new material now serves both purposes. Quick-release boots are now available for use in foundries and other places where it may be necessary to remove the boot quickly in the event of entry of hot metal.

Women's safety shoes are being sold in increasing numbers. The general popularity of shoes in preference to boots is shown by the statistics of one maker. Shoes sold for men alone totalled about 65 per cent of the sales of safety footwear of all kinds. The value of safety footwear is shown by two incidents referred to by workmen at a works safety committee meeting. In one case a 3½ cwt. load had dropped on to the toes of a man wearing safety boots. The leather was cut, but the man's toes were uninjured. Another man was using a heavy sledge hammer which slipped and struck the toe of his safety boot. He remarked afterwards, "Thank goodness I was wearing a safety boot".

Foot accidents have clearly demonstrated the need for every man to have two pairs of safety footwear. Men who normally wear them have had toe injuries while their safety footwear was being repaired.

Following complaints by men that the use of goggles was hurting their eyes the safety organization group of a large motor car firm suggested that an optician should be consulted, and one was brought in after the men had agreed to abide by his decision. This optician was able to assure the men concerned that the use of their goggles was in no way detrimental to their sight or health and that the strain they felt was just because they were unaccustomed to the use of goggles, the same effect being experienced by people who had not got used to wearing spectacles. The optician agreed to provide a written report for the benefit of the men and it was thought that calling him in had had a very reassuring effect and was enabling the firm to get more co-operation from the men in the use of goggles.

Most accident prevention groups are affiliated to the Royal Society for the Prevention of Accidents, and these groups, employers' federations, trade unions and civic authorities do much to stimulate local interest in safety in

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the factory, and, in 1955, there was considerable activity of all kinds. Contact between firms representing all industries in the district results in success stories becoming more widely known, as well as much valuable knowledge being pooled. Emphasizing the importance of this contact, an Inspector who regularly attends the meetings of one group says, "The representatives of the firms who attend are very keen but their background knowledge is limited. That applies to the majority of persons concerned with safety in factories in the District. Few, if any, realize that there is little hope that they will build up enough experience on the basis of what occurs in the particular factory with which they are concerned. There is a tendency to limit their interests to machinery and plant in their own factory and to the type of accident of which they have had experience in the past."

A special feature of one group this year has been the visits to member firms, followed by a kind of forum at the next meeting when points noted were discussed and answered by the representative of the firm visited. This exchange of ideas and widening of the horizons of safety and personnel officers and others by friendly visits to other factories is having a stimulating effect. At a recent meeting many members paid tribute to the tidiness and cleanliness of a large engineering firm which they had visited and they asked for details as to how it was done.

When so much good work has been done throughout the country, it is impossible to mention more than one or two items. For instance, the Gloucestershire Industrial Safety Group, formed towards the end of 1954, had a particularly successful year and did much to stimulate interest in, and impart information on, matters of health and safety both among its own members and among employers and employees generally. Forty-eight local firms, representing a variety of industries, had joined by the end of the year. Activities included three lectures, two works visits and three small exhibitions. Largely owing to the encouragement of the Mayor of Gloucester, the group held its own exhibition during National Safety Week. Fig. 5 shows part of the exhibition, manned by two apprentices, twin brothers, who greatly enjoyed demonstrating good and bad practice in the training of young persons. Poor lighting, unsafe wiring, handle-less files and broken hand tools, untidy hair and clothing, old boots, splintered workbench, uneven duckboards and general muddle at one bench, all have their counterparts at the other bench where tidy, efficient and safe methods are illustrated. At the request of the Rural District Council and with the help of a member firm, a shop-window display was given in the village of Nailsworth, a locality containing a certain amount of industry. Fig. 6 shows the display, which consisted of two panels illustrating safe and unsafe tools and equipment. Such displays, which are simple and effective, give publicity to accident prevention in localities which would otherwise not be touched. Much more could, I feel, be done on these lines.

In Scotland it has been a busy year for the Scottish Industrial Groups Advisory Council (S.I.G.A.C.). In addition to the regular meetings, three special matters have occupied the attention of the Council. In November the Council held its one-day Industrial Safety Conference in Glasgow, at which papers were given. Part of the "Stay Alive" exhibition sponsored by the Glasgow Corporation was devoted to an exhibition of industrial safety equipment, the organization of this falling largely on the shoulders of the Secretary of S.I.G.A.C. At this exhibition the Factory Department provided a stand, which was manned by Inspectors. In September, St. Andrews was the venue

TRAINING OF YOUNG PERSONS IN SAFE WORKING.

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FIG. 5.

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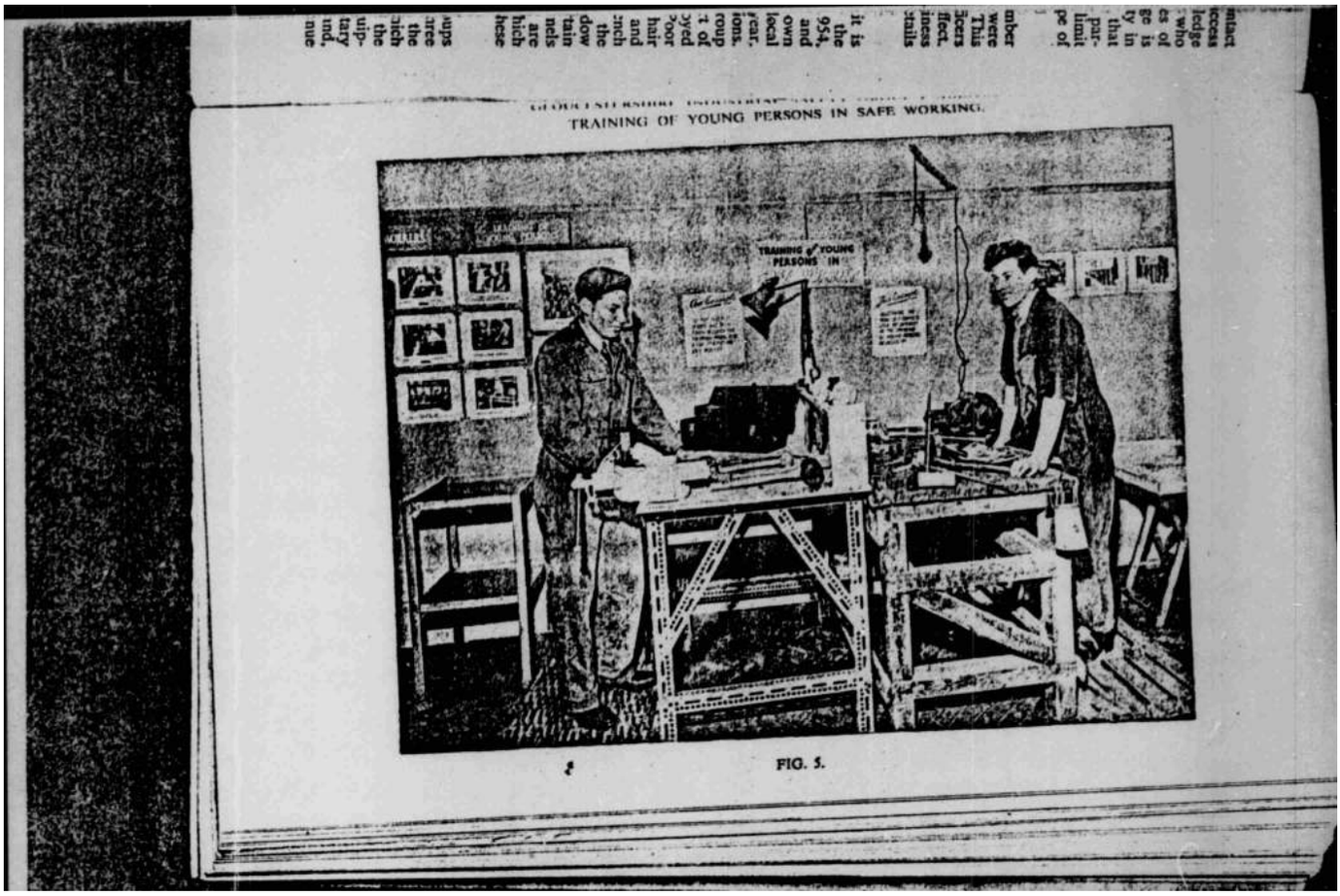


FIG. 5.

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SHOP-WINDOW DISPLAY AT NAILSWORTH.

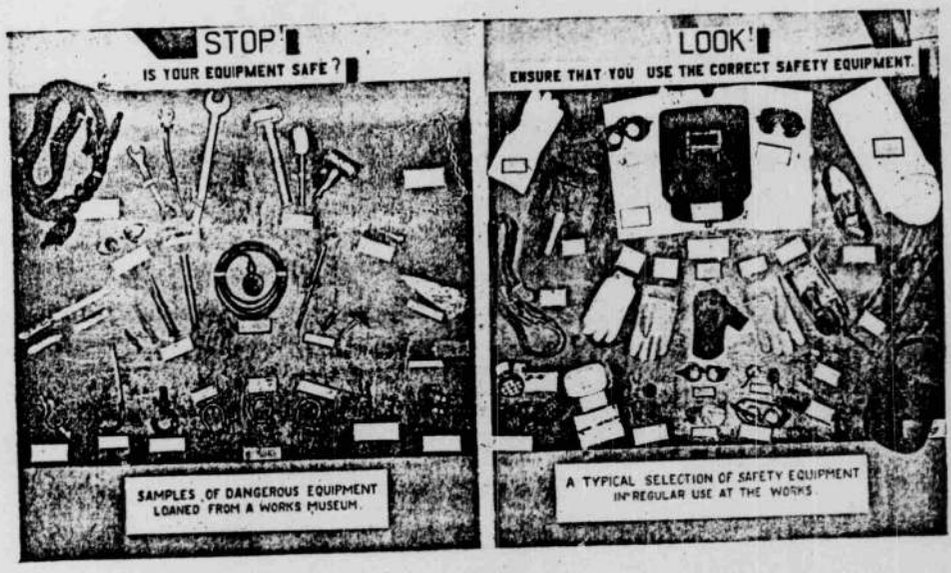


FIG. 6.

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of the first Industrial Safety Training Course to be held in Scotland. This was organized by R.O.S.P.A., and S.I.G.A.C. were responsible for ensuring good representation from Scottish firms.

An interesting development in the brick, pipe and tile industry since the end of the last war has been the paying of organized visits by members of the industry to each other's factories. These visits are primarily arranged to foster good fellowship and to stimulate production by showing new methods of working. It has become apparent, however, that they also have a very good effect on safety and result in improved working conditions. It was often said that this industry, like some others, tended to keep itself in watertight compartments so that improved methods of guarding machines did not as a rule spread quickly through the industry, but tended to exist only in isolated pockets throughout the country. At these inter-works visits, however, accident experience and new methods of guarding were discussed and new ideas taken away.

In docks, the local safety committees referred to in last year's Report have continued their activities. The National Association of Port Employers, through its industry safety committee at national level, keeps in touch with local activities and issues safety literature in the form of bulletins and specially designed posters.

Building Industries

Developments in accident prevention organization in the building industries were mainly restricted to the larger firms, many of whom were active in appointing safety officers and in promoting schemes to stimulate interest among their own and other employees and in the industry generally. One very large firm appointed five regional safety officers during the year; others also added to their safety staffs and many firms made their first appointments of one or more safety officers.

FIG. 6.

Most of the industry's special safety groups had a very successful year, but there were, unfortunately, some exceptions, where for one reason or another little progress was made. The London Building and Engineering Contractors Group, which meets at the Industrial Health and Safety Centre, slowly increased its membership and its Junior Group also flourished. But, despite effort, little impact was made on the smaller contractors, and attempts to form similar groups affiliated to R.O.S.P.A. throughout the country were not successful. Yet the smaller firms in some districts gave as their reason for not joining the general groups in their areas the fact that their problems were in the main rather different from those of factories, so that they wanted their own group. The Building Contractors' Section of the Birmingham and District Industrial Safety Group also increased its membership and by the end of 1955 over 50 firms were represented. In addition to lectures and discussions, good safety films were shown at some of the quarterly meetings. The Scunthorpe and District Building Industries Safety Group, formed late in 1954, did not have large attendances at their meetings, but the meetings were enjoyed and discussion was very animated. A highly satisfactory feature is that Trade Union representation is strong and it is hoped that the Unions will accept office in the future.

Lectures on the Regulations appeared to be successful in arousing interest. Those organized by the Ministry of Works in connection with the general building courses for foremen and apprentices at evening institutes resulted, in one area, in a sudden rise in the number of building accidents reported.

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Some firms had apparently not been previously aware of the legal requirements as to accident notification. At Wolverhampton a lecture was given to the general public. Another city arranged for a lecture on the Regulations to be given to the managers, foremen and safety officers of the public works department. In addition to co-operating in such schemes, Inspectors were invited by individual firms to talk to their foremen and members of the management.

Building exhibitions sponsored by the Ministry of Works and supported by local Employers' Associations, Trade Unions and Education Authorities were held in Grimsby and Doncaster. At each of these exhibitions the Department had a stand, on which photographs and examples of some good and some faulty equipment were displayed, and the stands attracted their full share of visitors to the exhibitions.

The view, expressed by one Inspector, that the smaller contractors know of the existence of the Building Regulations but seem to dislike any reminders about them, was unfortunately borne out by reports from all areas on the progress of accident prevention in the building industry. In too many cases, and even among larger firms, the appointment of a responsible person under Regulation 98 appeared to be purely nominal. It was not uncommon to be told that every foreman had been appointed. This does not constitute compliance with either the spirit or the letter of the Regulation. For directors, agents, managers or site foremen, such an appointment means additional work, which usually they cannot find time to do. Where a suitable person has been appointed as full-time safety officer, the results in accident reduction have been satisfactory.

Reports indicated that steel-erecting contractors were still insufficiently interested in accident prevention and that the men were quite prepared to accept "danger-money" in lieu of safety devices; a sad but true commentary on modern progress.

At large building sites, where up to a hundred or more sub-contractors may be operating, it is frequently most difficult to decide precisely who is responsible for covering a hole in the floor, or who should put up guard rails. It was to solve such a problem that safety committees were formed at certain power station sites. It was left to the main contractor to appoint a site safety officer, the Central Electricity Authority agreeing to co-operate by supplying an office, etc., and assisting in other ways. At one site the Authority arranged to provide instructors to train men in an approved method of applying artificial respiration in cases of electric shock.

Individual firms carried out some excellent work, of which only a few examples can be given. One building firm issued to their foremen on sites two large drawings. One is an isometric drawing showing construction of scaffolding, with notes on erection and with detailed reference to the appropriate Regulations in the Building Regulations. The drawing emphasizes that all foremen and chargehands are to ensure that the men can approach their work safely and carry it out in a safe manner. The second drawing deals in detail with crane erection and with a crab winch, also referring to the Building Regulations. On a number of sites these drawings were seen affixed in messrooms. Photostat copies had been taken and used by the other building contractors.

Several firms arranged for Inspectors to give lectures to foremen and others with a view to getting better compliance with the Regulations and thereby reducing accident rates. Roofing contractors in one district passed a resolu-

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tion that members should inform their Association when unsatisfactory conditions as regards safety were found and that, in the last resort, no member would work for a builder who would not improve matters. Letters were sent by the Association to the various builders' organizations and promises of support were received in reply.

A large factory with its own building section formed a separate subcommittee to deal with the Building Regulations, both at work being done by themselves and also at work done by outside contractors where the factory employees might be at risk. Inspectors gave advice on the Regulations and the Acts.

Training Schemes

Training of all types, of which examples were given in last year's Report, continued to develop. New apprenticeship schemes were inaugurated and old-established ones were modified and extended. In most instances, some stress was laid upon safety, health and welfare, as these subjects are becoming more widely recognized as most necessary adjuncts to vocational training. The co-operation of Inspectors was again frequently sought, both by employers and by the heads of technical colleges. Expanding industries, such as aircraft, in addition to industries in which employers' federations were originally instrumental in promoting training schemes were, as might be expected, responsible for many of the new schools for apprentices.

Progress is, however, not confined to the newer industries. A large shipyard, having a yearly intake of about 120 to 150 apprentices, developed a training scheme for the 15-year-old boys. In their first week, they attend a series of lectures by the personnel and safety officers; they are conducted round every department and have the functions of management, foremen, Trade Unions, etc., fully explained to them. Lectures are given by the works safety officer on the more detailed aspects of safety, such as the duties clauses of the Shipbuilding and the Woodworking Machinery Regulations. The boys spend their first year as messengers, etc., and begin their apprenticeship, with about a year's training in the school, at the age of sixteen. This is a sheltered shop where they are taught the elements of their craft and in this school there is also a follow-up on safety training.

An engineering firm started a training section for apprentices and other young persons. Machines painted in a distinctive colour were installed in a special section of the machine shop. The safety officer invited an Inspector to visit and advise on the highest degree of safety in this section. The trainees helped to instal the machines and then made the necessary guards. The scheme has one novel feature in that apprentices are given the task of designing and making guards for machines in the production shop. In this way they obtain a good practical training in safety.

A steel tube works extended its old-established apprentice training scheme to include a weekly lecture, by the firm's chief medical officer, on industrial health hazards, first aid and personal hygiene. Terminal examinations showed this extension of the syllabus to have been well worth while.

Although firms in general may realize the importance of having all the machinery in a training school fenced to the highest standards and of drilling the trainee in the use of guards, eye protection, etc., and in keeping the workshops tidy, some managements have not appreciated that care is invariably necessary to ensure that their intentions are duly carried out. In a successful

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school, in which training in safety plays an important part, it was said ruefully that it was necessary to supervise the supervisors to make certain that they always carried on safe practices. Unfortunately, too, it had been found that boys who were correctly trained in the apprentice school often degenerated when they were in the factory among older men who had long-ingrained habits of unsafe methods of work.

Instances of co-operation between neighbouring firms in similar industries were mentioned in last year's Report. A scheme, which took some time to materialize, was initiated by the Chairman of a local Engineering Industries Association and is administered by industrial consultants. Firms too small to run individual training schools pool their resources. Each firm engages its own apprentices, but they move among the co-operating firms, thus widening their experience. The education authorities encourage the arrangements.

Induction or initiation courses, lasting from one day to a week or more, were arranged by a number of firms both in the heavy and light industries. While such schemes cannot be looked upon as training, they assist in making entrants feel more "at home" and often link up with the true training schemes. Induction courses normally consisted of talks by the management or by personnel and safety officers on the firm's history, its production, its welfare services and safety organizations and also of tours round the works, conducted by a person competent to interest the newcomer and to explain something of the plant and processes seen. Some firms had to inaugurate, or adapt, such courses to meet the problems arising from the employment of foreign workers. A steelworks, for instance, extended its scheme for the benefit of Italians, and made "ad hoc" arrangements for any foreign workers of other nationalities.

Continued shortage of labour not only intensified the need for apprenticeship schemes, but appeared to bring a widening realization of the value of some form of training for workers at all levels. These schemes were mainly designed both to interest and attract workers and to render them efficient in the job in a shorter period of time than was otherwise possible, but they also enabled the new worker to receive carefully planned training in safe techniques by a qualified teacher, instead of taking his chance of possibly indifferent training by foremen, chargehands or other workers in the factory. Such schools prepare workers for many different types of job and the trainee is not sent into the factory until the necessary dexterity and basic knowledge have been acquired. At an old-established biscuit factory, the foremen and supervisors have ceased to be burdened with training and it was found that the method of using skilled trainers enabled the worker to become efficient and to earn a high rate of pay in about half the time previously taken. Instruction in factory safety, health and welfare is given by the chief trainer.

The training of foremen in management is no less important than the training of personnel in production. In addition to training foremen and supervisors in the content of the job and in safe methods of work, there is also an obvious need to instruct them in how to impart their knowledge to others. Inspectors reported that some firms fully realized the importance of these techniques of communication but that there was still much to be learned. Careful training should effect improvement in those who are not born teachers. If the foreman-pupil is unreceptive and incapable of changing his ways for the benefit of those entrusted to his care, arrangements should be made to ensure that the initial training of young persons and other learners is satisfactory from the safety angle.

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Throughout the year, courses for foremen and supervisors in various industries, including the building trade, were arranged by the Industrial Welfare Society and local education committees, by technical colleges, by employers' federations, by nationalised industries and by individual firms. Inspectors participated in many of these courses by advising on machinery and by giving talks. The Scottish Woollen Technical College held a two-day conference for foremen and welfare officers. A lecture, followed by discussion, gave opportunity of dealing not only with safety and fencing of machinery on general lines, but with comparatively new items of importance, such as the training of young persons on carding machines, the fencing of carding surfaces and of gill boxes. A series of courses for managers and foremen in wool textile mills, organized by the Recruitment, Education and Training Department of the Wool (and Allied) Textile Employers' Council, included lectures or discussions on accident prevention. In an industry like the wool trade, where the typical factory is comparatively small, particularly useful work can be done by employers' organizations in spreading information on accident prevention. Many firms in the North sent representatives to Lambton Castle to attend supervisors' training courses run by the Durham education authorities. The residential college at Burton Manor continued to arrange courses on supervisory management to which men and women come from a wide field. At a typical course there were men from the Midlands, South Wales, the North-East coast and London as well as from Lancashire and Cheshire, and they represented a great variety of industries.

The Central Electricity Authority, which undertakes systematic training of employees at all levels, introduced additional schemes during the year. These included a one-day preliminary conference on accident prevention attended by power station executives and safety officers. In October, the first residential training course for London safety officers was held at the Authority's Central Training Centre in Surrey. The course lasted a week. An Inspector, who attended on one day, learned from the members that it had been extremely useful and it appeared to have opened their eyes to the real work of a safety officer and to the breadth of his job.

The National Coal Board extended their five-year apprenticeship courses for coal-mining mechanics and electricians to those who are to be employed in the coke-oven works. During 1955, for the first time, a five weeks' preliminary course on basic safety principles was instituted.

British Railways opened a school which is most attractive in layout and internal decoration. Newcomers spend a full year there, receiving instruction and practical training in the manifold jobs with which they will be faced when they enter the railway workshops. Training in accident prevention is an important item in the curriculum.

On the whole, the year under review has shown a widening appreciation, in most industries, of the importance of including training in safety, health and welfare in all training for production and for management. It has also given ample evidence of the benefits which accrue from initial training and from refresher courses for professional safety officers and others engaged in the work of preventing industrial accidents.

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CHAPTER 4

Accidents in Special Industrial Groups

Accidents in Non-Ferrous Foundries

THE accidents reported from non-ferrous foundries have been classified and the analysis appears in Table 8.

TABLE 8

ACCIDENTS IN NON-FERROUS FOUNDRIES

1. Power-driven machinery (except hoisting appliances and hand tools)		105
2. Hoisting appliances:		
(a) Sling breakages	3	
(b) Falling or swinging loads	16	
(c) Others	12	
	—	31
3. Portable and hand tools (excluding eye injuries)		76
4. Burns (excluding eye injuries):		
(a) Molten metal:		
(i) Furnace	77	
(ii) Transportation	18	
(iii) Pouring	51	
(iv) Explosions	10	
(v) Others	40	
(b) Others	54	
	—	250
5. Eye injuries:		
(a) Burns	60	
(b) Use of portable or hand tools	15	
(c) Others	31	
	—	106
6. Falls of persons:		
(a) From heights	22	
(b) Into holes, etc.	7	
(c) On flat	38	
	—	67
7. Struck by falling bodies		228
8. Stepping on or striking against objects		74
9. Manhandling materials, etc.:		
(a) Strains	129	
(b) Others	154	
	—	283
10. Other		30
Total		1,250

The relative importance of the causations of these accidents is shown in Fig. 7.

If there is a typical foundry accident, it is the burn. Of these, excluding eye injuries, there were 250, of which 196 were due to molten metal, the others being due to contact with hot sand or other hot materials or objects. Many burns were due to metal flying when moisture was by some means or other inadvertently introduced into a melt. Out of 20 burn accidents reported in one District, 10 were caused by metal flying when feeding the furnace or crucible, and in many cases the material being fed was scrap which was either

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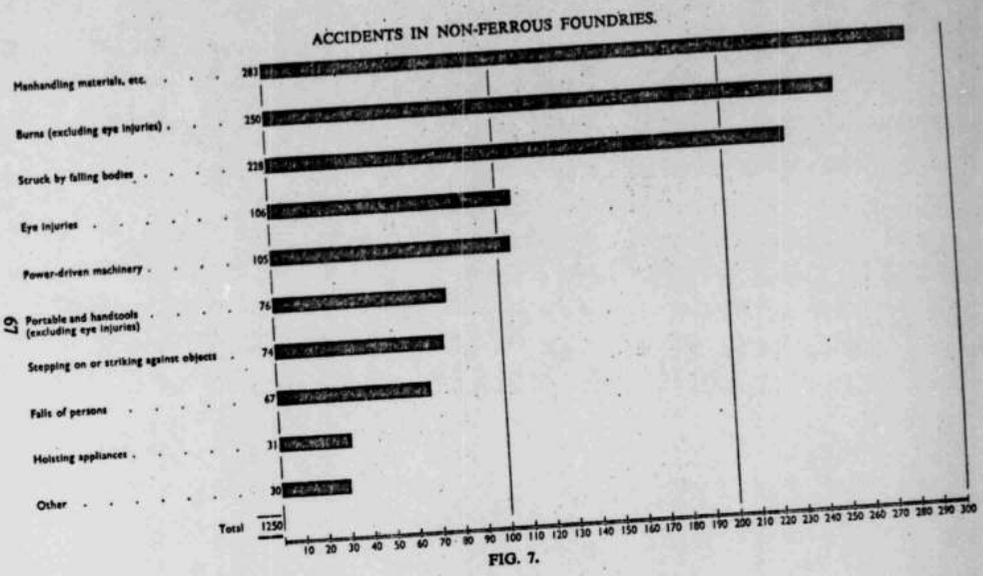

ACCIDENTS IN NON-FERROUS FOUNDRIES.
Manhandling materials, etc.
Burns (excluding eye injuries)
Struck by falling bodies
Eye injuries
Power-driven machinery
Portable and handtools (excluding eye injuries)
Stepping on or striking against objects
Falls of persons
Hoisting appliances
Other
Total
283
250
228
106
105
76
74
67
31
30
1250
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300

FIG. 7.

wet or impregnated with oil or suds. One District Inspector comments that, with all the accumulated experience of foundry accidents caused by the introduction of moisture in molten metal, it is surprising that such accidents can still occur. Careless introduction of ingots and other material into melting pots has been known to cause direct splash. This is due to the personal factor. In one District two serious accidents occurred involving the pouring of molten aluminium into water-cooled dies in the process of billet casting.

Although most firms take steps, for instance by pre-heating, to ensure that metal is dried before it is lowered into the furnace, in several cases these measures have been defeated by unforeseen, although not unforeseeable, circumstances which caused the metal to become wet or damp. For example, one accident was thought to have been due to rain leaking through a damaged skylight on to scrap metal stacked by a furnace ready for charging. A similar accident in the same works was probably caused by rain water overflowing from a gutter near the furnace during a heavy storm. The rain water may have collected in a skip holding the charge. Another burning accident occurred when a moulder, de-gassing molten aluminium in a crucible, used a plunger which was not quite dry to push the de-gassing tablet under the molten surface. This accident could have been prevented if the plunger had been held for a few moments over the crucible and dried thoroughly before immersion. It appears that the plunger, with others, had been stored in a wall rack overnight and had become wet when rain splashed from a leaky roof overhead.

When dealing with magnesium, extra precautions must be taken. A serious fire occurred in one foundry when the bottom fell out of a crucible containing 500 lb. of the melt. The pot was at its 73rd melt and had been examined at the 45th melt. Possibly, the man who examined the pot had been misled as to its thickness by the coating of dross, because inspection afterwards showed that the pot was of wafer thickness at the line of fracture.

The total number of foot accidents was 320, i.e., 25·6 per cent of the total. These foot accidents are included in the figures in Table 8 and are scattered throughout the 10 causations given in the Table. All Districts in which non-ferrous founding is an important industry comment on the number of foot accidents. In one Birmingham District, out of 54 accidents, 18 were to feet and, of these, the District Inspector considers that 12 might have been prevented if safety footwear, together with spats, had been worn. For instance, in a foundry in this District, one man who normally wore boots came to work one day in shoes and sustained burns to his foot when molten metal spattered from his ladle; the metal entered a space between his sock and shoe. Another Birmingham District comments that 15 foot accidents were reported from the non-ferrous foundries and that all of these could have been prevented if safety boots had been worn. All the firms had arrangements enabling the men to buy boots on hire-purchase if they wished. This picture from the older industrial area is in sharp contrast with that reported from a District containing a new town in which there is a non-ferrous foundry containing about 70 men. During the year, there were 9 accidents at this foundry, all slight, and the District Inspector thinks that the fact that only one of them was a foot injury was because a very large percentage of the employees availed themselves of a "cost price on deferred terms" sale of safety footwear operated by the firm. Many of the injuries to feet were, of course, due to causes other than burns. The Inspector for one District, reporting that half the accidents in his District occurred in the billet-casting department of a large aluminium rolling mill says: "A recurring cause of accidents in billet-casting was the fall of an ingot from a stack or from the hand, with resulting foot injuries. The works has a good safety organization and, but for the

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mechanical aids provided and the protective footwear used by many of those most exposed to the risk, these accidents would be more frequent."

Eye injuries reported totalled 106, of which no fewer than 60 were burns. Although these eye injuries do not, by themselves, form a high proportion of non-ferrous foundry accidents, they must all be regarded as actually or potentially serious and *prima facie* preventable. I quote two reports from Birmingham Districts: "It is most difficult to induce the workers to wear suitable eye protection. A serious blow-out occurred in one foundry when a cooler-bar, that is, a bar of metal added to lower the temperature of the melt, was being added to a pot. Molten metal flew out and seriously burned a man's face and eyes. He was wearing no eye protection at the time, although goggles and face screens were available. When an Inspector visited to investigate, other workers were doing just the same." "Although goggles or eye shields are provided in many foundries, many instances have been noted when they have not been worn. There were four eye accidents in foundries in the District due to splashing metal. In every case, eye protection was available but was not worn. Two of these occurred in the same factory within a few days of one another."

Fifteen eye injuries were caused during the use of portable or hand tools. One such accident occurred when a man was using a pneumatic hammer to fettle a propellor. This accident happened at a large foundry which issues goggles to all men requiring them and this foundry has also been a pioneer in developing fettling screens. The legal position is clear with regard to the fettling of metal castings involving the removal of metal where these processes are carried on by means of hand tools or other portable tools. Section 49 of the Factories Act, 1937, supplemented by the Protection of Eyes Regulations, 1938, requires that for these processes suitable goggles or effective screens shall be provided to protect the eyes of the persons employed. I cannot point out too often that the matter does not end there. Section 119 of the Factories Act, 1937, lays a duty on a person employed to use any means or appliance provided for securing his safety in accordance with this Act. Furthermore, both the occupier of a factory and the employed person may be guilty of an offence in the event of non-compliance with Section 119. There is little doubt that, but for the operation of Section 49, this figure of 15 eye accidents would be exceeded ; many of these 15 may not have involved processes scheduled in the Protection of Eyes Regulations.

Accidents caused by manhandling materials totalled 283, of which 129 involved muscular strains. The analysis of causation given in Table 8 shows that this causation is the largest, being responsible for 22·6 per cent of the total number of accidents.

The next most important causation in this Table is that of being struck by falling articles or materials, which caused 228 accidents, representing 18·2 per cent of the total. Accidents in this causation merit more attention than they seem to have received in the past. When one considers the movement of materials in non-ferrous foundries in terms of ton-miles, it is realized that there are plenty of opportunities for injuries to occur due to articles falling and striking persons. A careful survey of all the materials-movement in a foundry from the point of view of the possibility of articles falling would, I am sure, produce some interesting conclusions. Apart from the movement by overhead cranes, which is usually very well watched, there is a great deal of movement by conveyors or by hand or power trucks, during which such accidents occur. As well as materials-movement, precautions such as proper stacking to prevent collapse do not always receive sufficient attention.

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A most unsatisfactory method of moving a hot billet is illustrated by the following accident. The billet, which was 7 ft. long and 16 in. diameter, was placed upright and compressed in a hydraulic press to consolidate the metal. The billet was then withdrawn on a travelling table and had to be turned the other way up to repeat the process. To do this, a sling was placed round the billet at its lower end and lifted by an overhead crane. This caused the billet to fall over, then the crane-lift completed the turning operation. It was intended that persons should stand clear once the sling had been fixed, but one of the operators, who had been on the job for only a short time, went to look at the sling just as the crane began to lift. The falling ingot fell on his foot, crushing it, and his foot had subsequently to be amputated. After this occurrence, ingots which had to be turned were slung at their mid-point and turned in the sling.

Accidents caused by power-driven machinery (excluding hoisting appliances and hand tools) totalled 105. One District reports on two machinery accidents which occurred following accidental operation of machine controls. One accident was at a power moulding machine, a box on which had been filled ready for ramming. The moulder stumbled forward and his knee caught the control lever operating the ram, his arm being then trapped between the box and the ram head. Substantial steel plates have now been fitted round the control levers; a grab-rail has also been provided round the head to give a resting-place for the operator's hand so as to reduce the likelihood that he would rest his hand on the machine head and get it trapped. The second accident was at a core-blowing machine. A mould box, or core box, is clamped on a table by a vertical ram, and a horizontal hydraulic ram moves the table, with the box, up to a feed-hole in the face-plate. Sand is forced mechanically through the face-plate hole into the core box. A mould had been completed and the box removed. The operator leaned over to brush off with his fingers some sand which had dropped between the face-plate and the table-end. Accidentally, he operated the control valve and his fingers were nipped between the table and the face-plate. Investigation showed that the table could be cut back to give clearance at all times between the table-end and the face-plate hole.

The greater part of the finishing of non-ferrous castings consists of cutting off the risers, and this is usually done on band-saws. These machines are similar to those widely used in the woodworking trade. It is desirable that the standard of fencing should not be less than that required by the Woodworking Machinery Regulations, 1922, but the hazard is rather greater than in the woodworking trade, as the exposed portion of the blade must usually be considerably longer than for most woodworking operations. Moreover, objects to be trimmed are often fairly small, and the operator's hands approach near to the blade; also the likelihood of metal binding on the blade is greater than that of wood. Band-sawing is, however, a quick and convenient method of cutting off risers, but it would be well worth while to examine the possibility of safer alternatives.

Accidents still occurred at the delivery chutes of sand-mills, usually when persons attempted to free blockages of sand and were caught by the rotating scraper-blade. It is usually possible to guard these points.

Accidents at die-casting machines continued to occur and were sometimes serious. They were caused mostly by splashes of molten metal ejected as the dies closed or by trapping at the platens. While it is probable that the majority of die-casting machines are still unguarded at the trapping area, a good deal of progress has been made. Many of the guards provided are of an extremely

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primitive nature, but there are some which reach a high standard. One such guard exercises a control over the hydraulic system in much the same way as is done on hydraulic moulding presses in the plastics industry. The Zinc Alloy Die-casters' Association have been devoting much attention to the matter and have set up a Guarding Committee, on which the Department is represented. This Committee is impressed with the need for manufacturers to fit guards incorporated in the design of the machines, so that the purchaser of the machine may rely on a suitable guard being provided. The photo-electric method of safeguarding by means of a light beam has been considered but this has been discarded as not being appropriate for the purpose.

Accidents caused by portable and hand tools, excluding eye injuries, totalled 76. Abrasive wheels were responsible for a number of these. Accidents caused by abrasive wheels are described more fully in Chapter 6.

Rubber-Making Machinery

During the year, 270 accidents occurred on rubber-making machinery. These are classified, according to class of risk or type of machine involved, in Table 9.

TABLE 9

ACCIDENTS AT RUBBER-MAKING MACHINERY

Machinery or Plant		Number of Accidents
Traps:		
In material being reeled or between material and rollers ...	34	
Intake between pulley and conveyor band	7	
	—	41
Nips between rolls:		
Horizontal rolls	22	
Vertical calender rolls	3	
Miscellaneous rolls	9	
	—	34
Nips between fixed objects and rolls or material on rolls	7	
	—	7
Tyre making:		
Tyre-building machines	25	
	—	25
Cutting and pressing machines:		
Revolution and clicking press cutters and platens	18	
Power cutting knives	17	
Guillotine blades:		
(i) Power	5	
(ii) Non-power	11	
Tools of hand and foot presses	16	
Tools of hydraulic presses	9	
	—	76
Grinders		4
Extruder worms		1
Arms of trough mixers		3[1]
Proofing and buffing machines (abrasions at)		17
Gearwheels, pulleys, cams, etc.		9
Manipulating materials at machines		3
Fall of part of machine		3
Injuries caused by projection of material from machines		7
Miscellaneous machine accidents		40
Total ...		270[1]

Raised figures indicate fatal accidents (included in lower figures).

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The number of accidents caused at traps in material being reeled, or between material and roller, is a matter for increasing concern, 14 more having occurred than in 1954, and, although there were no fatalities, the injuries were severe, compound fractures and amputations being not uncommon. Investigation showed that there were four principal causes of the accidents; making first laps under normal power and speed, straightening creases dangerously near the intake, removing foreign bodies at or near the intake, and stumbling or falling which resulted in the hand being trapped. In most cases, trip wires were provided within easy reach of the operator but invariably the person trapped is more concerned about freeing himself than about stopping the machine, and the most that can be expected from these devices is that another worker who becomes aware of the situation will be able to stop the machine quickly. Whether such action will be taken sufficiently promptly to prevent serious injury is entirely fortuitous, therefore accidents of this kind can only be prevented with certainty by the adoption of positive measures which will prevent any person gaining access to the trap when it is dangerous. Almost invariably, the first laps in a reeling operation must be made by hand, and the operator therefore has his hands within inches of a potentially dangerous trap. Safe working can only be achieved if the arrangements are such that access to the trap is possible only if the machine is at rest and if the reel or box can then be turned only by hand or under the control of an inching device. An interlock guard therefore seems to be required. This solution appears to be simple, but in practice the geometry of the machine and its location may make such a guard unwieldy and cumbersome unless the design is carefully thought out; care must be taken to give every assistance to the operator by making the access doors light and easy to operate. The material being processed may be up to 6 ft. wide, and the batch may vary from only a few inches in diameter up to about 4 ft.; a conventional interlocked screen may leave an open floor space in which a person or persons can stand when the screen is closed. In some cases a "floating floor" was tried in lieu of an interlocked screen, the floor being so arranged that the trap or nip could only be reached by a person standing on the false floor. The false floor floats on springs arranged so that the floor is depressed when a weight much less than the weight of a man is imposed on it. The movement thus obtained is used to operate switches connected to the driving motor control gear. Such interlocking should ensure that the box or reel can only be turned by hand, or under the control of an inching device, so long as anyone is within reach of the dangerous nip. Should the machine have an appreciable overrun after the power is cut off, the arrangement would require to be such that a person, having tripped the machine, could not reach the nip before the machine was at rest. Reports of accidents caused while straightening material at or near the trapping point showed that, in many cases, the straightening attempted was quite unnecessary and was being done merely out of habit. In other cases, the straightening could have been done at a point well out of reach of danger or, alternatively, a device made for the purpose could have been used. Similarly, the removal of foreign bodies was often quite unnecessary and could in any event have been done at a point remote from the source of danger. It was clear from the accident reports that there were no insuperable difficulties in providing effective safeguards against these risks of trapping.

Accidents between nips of rolls showed a noteworthy reduction from the previous year, when the number reported was 57. The application of the sensitive bar guard to horizontal two-roll mills continued, but progress was not yet such as substantially to affect the accident rate for this type of machine. The greatest impediments to progress are the cost of conversion and the possible dislocation of production during the change-over. In spite of

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these difficulties, progress was satisfactory, although in some cases firms postponed taking action until pressure was brought to bear upon them. In the practical application of the principles of safe working to horizontal two-roll mills, the general tendency was towards a higher machine-setting relative to the operator, and a lower setting of the sensitive safety bar. In some recent installations the sensitive safety bar is located almost at tray level. Where the possibility exists that the operator may sit or lean on the bar, it is useful to remember that it can be made sensitive to pressure downwards, as well as inwards, by cranking the bar supports outward by the requisite amount. Bars in the form of rollers are becoming increasingly popular, especially for such operations as sheeting-off, where the batch is drawn out from the mill in sheet form.

There were 3 accidents at the intakes of vertical calender rolls, compared with 12 during the preceding year. Ill-fitting or distorted guards were the principal cause.

Accidents at tyre-building machines again took a heavy toll. It is very difficult to devise any positive safeguards for this class of work, and a reduction here depends on thorough and detailed instruction in working methods, coupled with constant maintenance of machine controls which, by the nature of the operation, are subject to very severe conditions of service.

Abrasions at proofing and buffing machines caused severe injuries. Many of the machines in this class consist of stiff wire brushes, or drums with projecting needles, and as the pressure necessarily exerted by the operators is in the direction of danger, slipping or stumbling is very likely to result in an accident to the hands. Since the work must be presented to an exposed portion of the wheel, complete guarding is impracticable, and every care should be taken to see that the working conditions are as safe as possible, a non-slip floor kept clear of piece parts and debris being essential.

Many of the accidents on miscellaneous machines were occasioned by the use of hydraulic and pneumatic jacking and clamping gear and similar manipulative equipment. It has to be stressed that little is to be gained by devising a mechanism to save manpower if, by neglect of ordinary safety precautions, its use results in an accident. Such devices require greater consideration before installation than do normal production machines, in order to anticipate and provide against possible hazards which may not be immediately obvious.

In November, the National Joint Industrial Council for the Rubber Manufacturing Industry held its second National Safety Conference. The Conference, which was opened by Sir Walter Monckton, was held in London, and the interest of the industry in safety was well demonstrated by the size of the audience and the liveliness of the discussions. The audience came from all levels in industry, from board room to shop floor, and represented a wide variety of factories, ranging from small firms doing jobbing work to giant tyre factories. One of the highlights of the Conference was the showing of a new sound-film demonstrating safe working at horizontal two-roll mills. This film describes simply and convincingly the principles of safe working against the very real background of the men who actually work these mills. The film is undoubtedly one of the best of its kind and is worthy of a wide showing. The Engineers' Advisory Committee of the National Joint Industrial Council was at the end of the year studying the dangers associated with running nips, and was considering ways and means of guarding, which will in due course form the subject of a report. In addition, it was hoped to publish a supplementary report on two-roll mills, which will show many practical

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examples of the application of the safe principles propounded in the now well-known "Report on Safe Working of Horizontal Two-roll Mills".

Paper-Producing Machinery

The number of accidents which occurred on paper-producing machinery during 1955 totalled 294, including 3 fatalities.

Of the individual types of machine involved, the greatest number of accidents occurred at reeling and slitting machines, at which 78 persons sustained injuries.

TABLE 10

ACCIDENTS AT PAPER-PRODUCING MACHINERY

Class of Machine	Number of Accidents	
Preparatory processes		19[1]
Paper-making machines:		
Transmission	4	
Wet end	13	
Press section	15	
Drying section	37[1]	
Calenders	40	
Reel-up	28	
Miscellaneous	11	
	—	148[1]
Finishing machines:		
Super-calenders	15	
Reelers and slitters	78	
Cutters	29	
Miscellaneous machines	5	
	—	127
Total ...		294[3]

Raised figures indicate fatal accidents (included in lower figures).

The Joint Standing Committee on Conditions in Paper Mills continued to meet, reviewing accidents and discussing new points as they arose. In general, there has been fair progress with the work of complying with the Agreed Rules. The industry is taking an increasing interest in accident prevention and the Employers' Organization set up an active Safety Committee which considers matters of difficulty in the industry, and receives from the employers particulars of all reportable accidents, which are studied on a statistical basis according to causations.

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CHAPTER 5

Accidents in Special Causation Groups

Crane Accidents

THE total number of persons involved in crane accidents during 1955 was 3,896, a slight but not significant decrease of 44 in the figure for the previous year. The number of fatalities was 41, as against 64 in 1954.

Table 11 shows the causes of accidents and the types of crane involved.

TABLE 11

CRANE ACCIDENTS: ANALYSIS BY CAUSATION AND TYPE OF CRANE

Causation	Overhead Travelling Cranes	Travelling Jib Cranes (other than mobile)	Mobile Jib Cranes		Stationary Jib Cranes		Other types of Crane	Total Number of Accidents
		Power	Power	Hand	Power	Hand		
Run over or crushed on overhead gantry	45[1]	—	—	—	—	—	—	45[1]
Crushed between part of overhead crane bridge and structure of building	6	—	—	—	—	—	—	6
Fall from crane, gantry or approach	15[3]	15[1]	5	—	2	—	—	37[3]
Struck or run over on ground by crane	—	18[1]	58[3]	—	—	—	2	78[4]
Crushed by crane slewing	—	8[1]	2	—	—	—	—	10[1]
Crushed between load and some other object (except sling)	468	136[1]	67	6	35	1	14	727[3]
Crushed between load or hook and sling	313	51	21	1	10	1	7	404
Swinging load, hook or sling	380[2]	216[1]	114	2	29	—	19	760[3]
Load or hook fouling some other object	204[3]	108[3]	36	2	7[3]	—	11	368[9]
Struck by descending load	33[1]	42	15	—	2	—	4	96[1]
Load or part of load falling from sling	460[4]	185[3]	92	10	32[3]	2	17	798[9]
Failure of sling, crane chain, crane rope, hook, etc.	55	29[1]	11	—	10	—	7	112[1]
Failure of crane mechanism	28[1]	5[1]	13[1]	2	13	—	2	63[3]
Trapped by or otherwise involved in crane mechanism	42	18	31	5	11	3	4	114
Jib breaking or falling	—	7	19[4]	1	15	3	—	45[6]
Collapse of crane	4	—	—	—	11[1]	1	2	18[1]
Overturning of crane	—	16	51[1]	2	1	1	—	71[1]
Overwinding	12[1]	1	—	—	—	—	—	13[1]
Struck by winding handle of hand crane	1	—	—	9	—	20	—	30
Causes other than above	48	19	14	5	4	5	6	101
TOTALS	2,114[13]	874[12]	549[9]	45	182[5]	37	95	3,896[41]

The raised figures indicate fatalities (included in the lower figures).

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A most welcome feature was the reduction in the number of accidents due to persons being run down or crushed on gantries by overhead travelling cranes. The downward trend from 61 accidents in 1953 was maintained, 45 people being involved in this type of accident in 1955 by comparison with 51 in 1954. While it was evident that more and more firms were taking effective steps to prevent cranes on overhead gantries from approaching to within 20 ft. of any place where persons were working on or near the crane track, there were still many instances of factories in which no effective arrangements existed to ensure this. Accidents still occurred which indicated only too clearly that there must be no lessening in the effort to impress upon users of overhead travelling cranes the necessity for a well-established drill and good works discipline, if accidents due to persons being struck or crushed by cranes on overhead gantries are to be eliminated. An accident which illustrated the necessity for strict adherence by all concerned to the safety system in force occurred to a painter who lost part of his hand while gripping the longitudinal crane rail. The walls near the track had received two coats of paint and while this work was in progress red flags were displayed near the gantry as a warning to the crane-driver who, on approaching a flag, stopped the crane and sounded a hooter, waiting until the "all-clear" was signalled before proceeding further. On the day of the accident, the painter climbed to the gantry to add a third coat of paint, the flags not being displayed at the time; the crane-driver, unaware of his presence, drove the crane over the portion of the track on which he was working. The system was by no means foolproof, but on this occasion it broke down because of an oversight on the part of the injured person. Experience has shown that one of the most effective methods of preventing accidents of this kind lies in the adoption of a "permit-to-work" system, used in conjunction with stop blocks securely attached to the crane rails and electrical isolation for the portion of track over which cranes must not travel.

The number of persons injured as a result of falling from cranes or their approaches is the same as in 1954, but during 1955, 3 workers died as a result of such falls. Fifteen of the accidents occurred at the approaches to overhead travelling cranes, where in most cases the means of access left much to be desired. Rather more than half of the falls took place from travelling cranes with wheels at ground level. In such cases, the distances through which the injured persons fell were comparatively small, but nevertheless many sustained serious injuries. Facilities for access to the driving cabins on cranes of this type are often very unsatisfactory, especially in the case of old cranes; because of the proximity of the driving platform to the ground, access ladders or proper stepping points are not provided, and it is often left to the crane-driver to climb to his place of work as best he can. Even on cranes where the driving platform is only a matter of 2 or 3 ft. from the ground, proper footrests and secure handholds should be provided.

The number of accidents attributable to faulty slinging and to errors in signalling remained approximately the same as in previous years. The danger of divided authority in the matter of signalling was exemplified by a case in which a man was killed by being crushed by a large skip. The crane-driver, acting under the instructions of a chargehand, had emptied the skip and returned it to a platform. A slinger removed the sling but, before the hook at the end of one leg was clear of a projection on the skip, the chargehand signalled to the crane-driver to move the crane. The hook pulled the skip over on to the slinger, who died from the injuries sustained when he was crushed.

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As many as 727 people were injured as a result of being crushed between the load and some other object. Suspended loads fouling some other object accounted for injuries to 368 persons; the principal causes included bad housekeeping, where the material which the load fouled was carelessly stacked, and the driver being unsighted when the load was being traversed or slewed.

Crushing (mainly of the fingers) between the load or hook and sling caused 404 accidents, an increase of 30 on the figure for 1954. Included among these is a type of accident which is becoming more frequent but which at one time was never heard of, namely, accidents which occur when the unloaded hook becomes caught by a worker's glove and the hook cannot be released before the hand is trapped by the sling. In two such instances, the person wearing the glove was lifted some height into the air before the glove gave way, allowing him to fall to the floor. While the wearing of gloves for the protection of hands from cuts and abrasions, especially when handling sharp-edged plates, is to be encouraged, there must be no space for the point of the hook to enter, therefore the gloves must fit properly and must not have holes.

Swinging loads caused 760 accidents, as against 812 from the same cause during the previous year. One fatal accident due to a swinging load occurred when an attempt was made to lift a large canister, the centre one of three on a wagon. The crane-driver commenced to lift before the slinger was out of the way, although he was aware that the load would start swinging as soon as it was clear of the other canisters. It is not known whether the crane-driver received a signal from the slinger, but he could observe the operation clearly and should not have attempted to lift until the crane jib was in such a position as to make a vertical lift.

An even more dangerous consequence of inclined lifting than the swinging load is the possibility of overloading the crane. An example occurred at an old wharf which was being dismantled, the timber piles extracted being floated on the water. A steam crane of 5 tons capacity was brought as close as possible to the edge of the quay; three piles, totalling 3¼ tons dead weight, were slung together and the sling was attached to the crane hook. These particular piles were floating well beyond the radius of the jib and the intention was to pull them gently towards the quay by means of the burden rope before an attempt was made to lift. A similar operation had been carried out before without incident, but on this occasion the sling was not attached near the centre of gravity of the load and, instead of the piles being towed towards the crane, one end was lifted out of the water. Although the actual weight of the piles was less than the safe working load of the crane, the inclined pull applied at the jib-head was greater than that allowed by the stability of the crane, with the result that the crane overturned.

Injuries caused by moving parts of the crane mechanism totalled 114. A substantial number of these were due to the trapping of a person's hand between the moving hoist rope and the snatch-block return sheave. In many cases when the hoisting rope is not vertically over the load, slingers hold on to the block in an attempt to minimize the swinging which is inevitable as the load is raised. In such cases, there is a real risk of trapping unless the block is fitted with guard plates on the in-running side. Another type of accident occurred in the course of repair or maintenance work on the bridge of an overhead travelling crane. Hands or feet of men undertaking such work were crushed between the crab-wheels and the cross-traverse rails. When a man is at work on an overhead crane bridge it is imperative that he be accompanied by a workmate who is constantly at hand to take action in

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case of emergency, while the crane driver should be under the sole instructions of the man on the bridge.

Falling jibs, while not contributing greatly to the total number of crane accidents, are invariably responsible for injuries of a very serious nature. During the year, 45 people were victims of such accidents, 4 of them being killed. Fifteen of these accidents concerned stationary jib-cranes. Most of these were Scotch derrick cranes, the fall of the jib being due to failure of the interlocking mechanism between the jib-clutch and pawl and, while it is usually difficult to obtain a consistent story of the sequence of events after an accident of this type, there was often enough evidence to justify the conclusion that the practice of driving out the jib on the luffing motion had been responsible. In so doing, the driver sets the motor in motion to start the jib lowering and accidentally lowers the pawl into contact with the ratchet. The momentary stopping of the derricking drum then causes the rotating part of the clutch, still driven by the motor, to be forced out of engagement. At the same time, the pawl also disengages so that the derricking drum is free to revolve under the weight of the jib; the jib then falls at increasing speed, completely out of control, until it either reaches the ground and is smashed or is pulled up by the drum anchorage, when the drum may break away from its bearings.

On mobile cranes and rail travelling cranes, mechanical causes of accidents were various, ineffective brakes and overturning being the chief sources of trouble. Cases of overturning on all types (stationary and other) of jib-crane totalled 71. As usual, the chief cause was overloading. This was frequently the result of attempting to raise a load in excess of the safe working load of the crane at the particular radius, but another prevalent cause was the sudden braking of a rapidly descending load nominally within the capacity of the crane. Overturning also occurred when lifting loads with the hoisting rope at an angle to the vertical, so that the overturning moment was increased beyond that permissible at the particular radius of the jib. Overturning was also caused by swinging loads, the swinging being initiated either by slewing at excessive speed, or by too sudden a stoppage or reversal of the slewing motion. Another case of overturning was excessive counterbalance in the tail. A rail-mounted jib crane with a jib of fixed radius was altered so as to work at an increased jib radius and, in order to maintain a satisfactory factor of stability, extra weights were fitted to the tail. Some time afterwards, when the crane was travelling without a load and with the jib at right angles to the track, it toppled over backwards. The alterations had been carried out without consulting the makers and the amount of ballast added to the tail in order to increase the load-carrying capacity of the crane was excessive.

Each year a certain number of accidents occur, some causing serious injuries, when the winding handles on hand-operated cranes rotate out of control at high speed and strike one of the operators or another person standing within reach. In nearly every case the accidents occurred when the load or the jib was being lowered by the handle alone, the cranes having no other control capable of sustaining the maximum safe load or of bringing a descending load to rest. Brakes should always be fitted on hand-operated cranes. Furthermore, attempts should never be made to control the descent of a load by the use of either the handles or the brake alone. In such circumstances each should be regarded as complementary to the other.

Transport Accidents on Factory Premises

Rail Transport

Rail transport accidents, which have been steadily increasing in number since 1950, showed this year an appreciable decrease. This year's total of

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2,403 is the lowest recorded since 1948. Other types of powered vehicle accidents have, however, once more steeply increased, and the inference may be drawn that the swing-over from rail to other forms of transport is continuing. In fact, disused lines of sidings on factory premises have in some cases been taken up, releasing valuable ground for production purposes.

The heavy metal industries are, of course, the largest industrial users of rail transport and, on the basis of accidents notified, they have this year achieved a 15 per cent reduction in rail transport accidents. Other industries, though with some notable exceptions, have achieved comparable percentage reductions, the net effect being a 10 per cent reduction in the total. A change-over from rail to other forms of transport is, no doubt, not the sole reason for the reduction; safety organizations have devoted, and are continuing to devote, a good deal of attention to rail transport accidents; this year's figures should encourage them to persist with their efforts.

Methods of coupling ingot cars and scrap-pan bogies in steelworks have been under consideration by a Sub-Committee set up by the Accident Prevention Committee of the British Iron and Steel Federation, on which the Department has been represented. Accidents on these vehicles operating on rail tracks, although not numerous, are often serious, sometimes resulting in permanent disablement or loss of life. The comparative infrequency of accidents is due in no small measure to the skill and experience of the drivers and shunters employed.

Experience indicates that with present types of couplings some accidents occur either because they cannot be prevented by the skill of the workmen or because there is some temporary relaxation on their part. The most serious type of injury to a shunter arises when he has to go between the vehicles to couple or uncouple. He may then be crushed between the vehicles or knocked down and run over. If the coupling operation is awkward to perform, there are numerous secondary risks of injury. It has always been regarded as important that a shunter should not be required to go between vehicles for the purpose of coupling-up, the actual coupling operation being done by means of an appliance when the shunter is clear of the track. The Report of this Sub-Committee should perform a useful service by calling attention to the dangers that may be anticipated from the use of certain types of coupling, and by recommending the adoption of safer couplings satisfying certain basic requirements necessary to ensure safety.

One Inspector draws attention to what may prove to be an excellent new coupling arrangement for steel ingot bogies. A single link is used with long-handled horizontal pins fitted to the bogies so as to work in much the same way as ordinary door-bolts. The mounting on the bogie is so designed that the coupling link is held horizontally in correct position for coupling. All that has to be done by the shunter when the two bogies come together is to push home the handled pin. Previously the shunter had to get between the bogies and lift up the link with one hand while he inserted a short-handled pin with the other. The new pins are designed to lock by a half-turn and they are designed to fit into the link loosely enough to avoid difficulty in coupling when on a bend. A supplementary long-handled tool is being provided for moving the link slightly for alignment when coupling on a bend. The automatic couplings provided in some steelworks are very casual and readily spoiled by spillages of metal, which are almost unavoidable. The new coupling is relatively cheap and is easily fitted and the buffers of the bogies act as "umbrellas" so that metal does not fall on the mechanism.

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An interesting experiment in rail safety has been made in one factory by the installation of an automatic electric warning light at a level crossing within the works. The light is operated by a locomotive or wagon at a point about 50 yards from the crossing and is switched off automatically when the train clears the crossing by some 20 yards. This device has proved so successful that other crossings are to be similarly safeguarded. Good maintenance with frequent inspection to ensure proper operation is, of course, essential with such a device.

In order to minimize risk of accident when moving wagons by means of a capstan, a Dock Authority has prepared a code of practice based on the experience of a number of users. In the interests of safety, the code provides for the following: mechanical capstans to be operated only by authorized and competent attendants; the hauling-rope hook to be attached to the wagon safely and in such a manner that the hook will automatically disengage if the wagon overrides the capstan; ropes not to be applied to rotating capstans; the operating gear of the capstan to be kept well away from the moving parts, but an emergency stopping device to be provided near to the barrel; only one person to be allowed in the vicinity of the capstan at any one time; only one hauling-rope to be on the barrel at any one time; capstan ropes not to exceed 120 ft. in length; the wearing of gloves by capstan operators to be prohibited, and wagon doors to be properly closed and fastened before a wagon is moved. These precautions are in addition to those required by the Locomotives Regulations, 1906, in relation to the use of capstans.

Despite the progress being made, during the year 28 fatalities occurred associated with the working, loading or unloading of rail transport. Some of these were due to the complete ignorance of pedestrians as to the dangers they were incurring. In a large steelworks a group of workers and office employees were standing on a works road waiting for a line of wagons to move and give them free passage. The two wagons at the crossing were not coupled and the engine eased back to gain room to push the shunt forward, leaving a gap of perhaps 6 ft. between the two uncoupled wagons. Immediately, one of the office workers tried to dash across the line through the gap, despite the presence of a shunter. As he did this, the engine backed the shunt up, the gap closed and he was killed. It is difficult to believe that today in a great steelworks there is anyone who could be unaware of these dangers. The management has now begun courses in general safety in the works for office workers.

The movement of railway wagons is always fraught with danger, and the use of inappropriate means adds to the hazard. This is illustrated in the following account of a fatal accident. Loaded wagons were being moved along a line of rails by means of a 5-ton motor lorry. A towing chain was secured to the lorry and to the coupling attachment of the wagons; then, with the lorry running between the rails (which were set in concrete) sufficient momentum was imparted to the wagons so that when the lorry suddenly turned off from the rails and stopped, the towing chain being then slipped from the wagons, they ran for the requisite distance under their own power. At the time of the accident, something went wrong with the timing of the operation; the employee who was about to detach the towing chain from the front of the moving wagon after the lorry had stopped failed to do so, and he was trapped between the chain and the front of the wagon, which was dragging the braked lorry at the same time. He received severe crushing injuries from which he died shortly afterwards. As a result of this accident, the firm purchased a shunting tool for the mechanical handling of wagons when a locomotive was not available.

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Other Powered Vehicles

During 1955, 6,867 accidents were notified as occurring in connection with the working, loading or unloading of powered vehicles, other than railed vehicles. This is more than double the corresponding figure in 1948. A slight slackening in the rate of increase during 1952/3 has by now been compensated by the rapid increases of 1954/5, and we are faced with the unpalatable fact that since 1949 this class of accident has been increasing at the rate of about 500 per year, an increase which shows no sign of slackening, and which is not paralleled by that in any other class of accident. During 1955, there were 35 fatalities (included in the total of these accidents).

The number of vehicles at work has, of course, increased greatly during the corresponding period (although any estimate of their number must be pure guesswork). It is also true that the use of these vehicles has saved a vast number of manhours of manhandling, hand-trucking and so on, with their attendant risks. Nevertheless, this seemingly relentless increase of 500 accidents per year at first sight reflects little credit on those concerned with the planning and execution of mechanical transport operations. Perusal of accident reports gives the impression that powered vehicles are often operated with scant consideration as to whether the factory layout or terrain is suitable or even as to whether the vehicle is properly maintained and roadworthy.

A fatal accident occurred in the yard of a large works, when a man was crushed between a reversing lorry and a girder which he was helping to push along on a trolley. The lorry had been backed into the main roadway in the factory and was left stationary while the driver went into one of the adjacent departments, to see if that was the place to which he had to make a delivery. Having ascertained that the correct department was further down the road, he came out and walked to the back of the lorry to see whether the road was clear. Seeing no one, he came back to the front of the lorry and, after glancing in his driving mirrors, reversed for about 12 ft., when he felt a collision. In fact, when the lorry driver was at the back of his vehicle, two factory employees, pushing an 18 ft. long steel girder on a two-wheeled bogie, were coming down the near side of the lorry. As he walked back to his cab and got in, they were coming round to the back of the lorry, and as the lorry was between them throughout, neither party saw the other. The roadway was flanked on both sides by noisy departments which prevented the driver from hearing the bogie wheels on the road. This accident clearly demonstrates the risks associated with the movement of traffic in works yards where space is often restricted. Since the accident, the firm concerned have made a turn-round for lorries at the end of the roadway, and have so been able to prohibit reversing.

An illustration of the dangers of works trucks and of the poor state of repair of some of them is given by the following accident, which ended fatally. A labourer was cleaning windows in a passage, using one section of an extension ladder. The driver of a battery-driven truck swung his truck into the passage and did not notice that the man was on the ladder until he was quite close to him. The driver attempted to stop the truck by putting the motor into reverse but the controller jammed; he then attempted to use the foot-operated parking brake, which was also ineffective; the end of the truck then hit the ladder, causing the labourer to fall to the floor. Following the accident, it was found that the truck in question, which had been bought in 1925 as a second-hand article, had a defective parking brake (although this would have been of little use in any case in an emergency of this type). The truck had a foot-operated Klaxon horn but this was disconnected. There

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was also a history of previous trouble with the controller. Needless to say, since this accident the use and maintenance of internal transport have been more strictly supervised.

Many accidents, some fatal, occurred during the unloading of lorries. In one of the fatal cases, timber fell when the securing chain was loosened, and in the other, a load of patent boarding with a highly polished surface slid off the lorry when the ropes were removed. A man helping with the unloading was killed by the falling load in each instance. It seems that more care is needed in fastening loads and that it should be recognized that materials which are securely stacked on loading may well be unstable at the end of the journey.

From time to time, accidents occur in which persons engaged in the delivery of beet from farms to sugar-beet factories fall from the elevated roadways into the silos. The beet is normally delivered to the factories by motor lorries of various sizes which discharge the beet over the sides of a viaduct into the silos, at the bottom of which runs a gulley or flume 20 ft. below the roadway. The lorries are drawn up alongside, or backed against, a kerb 15 in. high, depending on whether the lorry is designed for side or end tipping, and in the course of unloading, the persons engaged in unloading are liable to fall from the lorry to the flume below. A contributory cause of these accidents is the unregulated manoeuvring and discharge of these lorries. In this industry, rules have been drawn up and exhibited in conspicuous places and brought to the notice of those delivering beet to the factory. Observance of the rules is supervised by traffic controllers specially appointed for the purpose and wearing distinctive armlets. The rules provide for the following: observance of the directions of the traffic controller; the beet to be progressively tipped, starting at one end of the silo and proceeding towards the other end, so that after the first few loads the bottom of the silo will be covered with beet; lorry drivers' mates to dismount from the vehicles and guide their drivers when lorries are reversing; no standing on top of the load in the lorry during discharging; no standing or walking on the kerbs; pins of tailboards and side-boards to be withdrawn before the lorries reach the kerbs; adequately strong chains to be used to secure side-boards; and side-boards not to be lowered beyond the level of their lorry floors. In addition to these precautions, stout stanchions, inclined to the vertical and about 6 ft. apart, were fixed, as an experiment, along part of the wall of one silo at about 3 ft. to 5 ft. below the kerb. Taut wire ropes were stretched between the stanchions, so arranged that although beet would pass through the grid, a falling man would be caught. It was found difficult to attach the stanchions securely to the existing concrete wall of the silo, and in consequence the falling loads quickly broke down the grid. In the case of all new silos, however, a somewhat similar arrangement incorporating bars instead of ropes will be provided. The value of the rules is illustrated by the fact that only one accident of the type which they are designed to prevent occurred in all sugar beet factories during the year. In that case, a lorry driver, while standing on a silo kerb to withdraw the pins securing a side-board of his lorry, slipped and fell into the silo. These rules might very well be adopted, *mutatis mutandis*, in other industries where materials are tipped into silos, etc.

Tipping by dumpers over the edges of pits not infrequently causes fatalities when the dumpers run or fall over the edge, due either to lack of attention on the part of the driver, to collapse of the ground or to the absence of proper stops for the vehicle wheels.

A dumper was being used to tip broken bricks into a knothole at a brickworks. As bricks were being tipped the dumper slipped into the pool and

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the man was trapped in the dumper in deep water. It had been the practice to back up to a sleeper but it seems that some bricks on the edge of the tip gave way.

Two fatal accidents in one District in the course of a few days were also caused by dumpers used for tipping rubbish over the edge of tips. One accident occurred at about 5 a.m., towards the end of a night shift. The deceased man was an experienced and reliable driver and at the time of the accident was reversing his vehicle to the edge of the tip under the direction of a signaller. He failed to stop after repeated shouts from the signaller, who was just about three yards away from him. He showed no facial sign of any consciousness of approaching danger and it was just as though he had momentarily fallen asleep at the wheel. He had worked through the night in a normal manner, visiting the tip and tipping his vehicle, and according to the evidence was quite fit and in good spirits. Sleepers were arranged along the edge of the tip but in this case it was stated that they were not meant to act as stops and that normally the wheels of the dumpers were not brought into contact with the sleepers. The firm is now carrying out experiments with a form of stop consisting of a baulk of timber supported at the ends and arranged so that a dumper could not ride over it, yet placed low enough to enable the dumper to be tipped. The end supports are to be anchored by adjustable ropes so that the stop can be conveniently moved as the tip advances. In addition, it is proposed to experiment with a safety hook which will be attached to the dumper before it approaches the edge of the tip. As a temporary measure the firm arranged to have the dumpers tipped a few feet away from the edge of the tip and rubbish pushed over by a bulldozer. Possibly that will prove the safer method of tipping rubbish.

Another fatal accident in the same District was apparently attributable to the lack of experience of the driver, who drove his vehicle over the edge just as he was about to tip the load. It is thought that he mistook his controls. Drivers for such work need, of course, to be men of experience and reliability. In both the cases the dumpers had reversible seats to enable the driver to face forwards at all times, but the seats are not, in practice, usually reversed just for tipping. It is a little trouble to reverse the seat, as a catch must be released and reconnected, and normally the seat is used in reverse only for travelling substantial distances with the vehicle running in the reverse direction.

The grave danger of persons being trapped by the bodies of tipping lorries was stressed by a series of fatalities during the year. These accidents show that a worker may be reaching across the chassis under the raised body, for the purpose of making an examination or carrying out a repair, when the body falls, either because of inadvertent operation of the controls or because of the sudden freeing of the body after it has become jammed in the raised position. It is not unusual for tipping bodies to fail to return normally from their raised position. Such an occurrence may be caused by mechanical defects, such as a bent or damaged ram, by distortion of the chassis and binding of the body hinge pivots (due to uneven ground upon which the lorry may be standing), by excessive body overhang or by sticking of the load in the rear of the body. When a vehicle body fails to return normally after operation of the release valve, the oil drains out of the ram cylinder, allowing rapid descent of the body as soon as the cause of the jamming is removed. In view of these accidents, approach was made to Associations representing the principal makers and users of tipping lorries, and action on the following points was agreed upon:

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(1) That all drivers and other persons working on or near tipping lorries should be warned of this trapping danger and instructed in the use of props. (Suitable props could be carried on the vehicles.)

(2) That permanent notices warning persons of the danger should be fixed on both sides of all new and existing tipping lorries, preferably at the rear corners of the cab. The following words are suggested, in letters not less than ¾ in. high, "Danger: do not reach under raised body unless it is propped". (Suitable warning notices of a durable kind are now obtainable.)

(3) That the controls for the tipping motion, including the release valve, should be in the driver's cab or in such a position that a person operating them is not in danger of being trapped. The release valve on some existing lorries is situated behind the cab; it should be moved from this position or fitted with an extended spindle, so that the operating wheel itself is not in the space between the cab and the body.

(4) In order to prevent inadvertent operation of the release valve, the tipping gear controls on all new lorries should be provided with some form of automatic locking device.

All makers and users of tipping lorries are strongly advised to take appropriate action on the above-mentioned points.

CHAPTER 6

Accidents at Various Types of Machinery

Abrasive Wheels

DURING the year, 1,501 reports were received of accidents and dangerous occurrences in which abrasive wheels were involved. These accidents have been classified as follows:

Due to contact with exposed part of wheel ...	809
Eye injury from particles thrown off by wheel ...	235
Due to projection of work by wheel	189
Bursts of wheels	184
Miscellaneous	84
Total	1,501

Apart from wheels on a few specialized automatic machines, it is impracticable to guard abrasive wheels completely, since some part of either the wheel periphery or the side must be exposed for the presentation and manipulation of the work. The character of most manual grinding operations is such that the pressure of the operator's hands is directed towards the exposed part of the wheel, so that any slip or stumble will probably result in injury. Of the 809 injuries due to contact with the exposed parts of the wheel, most occurred during manual grinding. In some instances, the operator's fingers were jammed between the work and the wheel or between

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the wheel and the toolrest. Jamming between the work and the wheel usually occurs when the work tilts on the workrest or, where no workrest is used, when the wheel takes charge and rotates the work. For the most part, the articles being ground did not lend themselves to the use of holders, which would have enabled the work to be done with little risk to the fingers, but there were cases where holders could have been used successfully, such as in the grinding of small repetition piece parts. The only reason why holders were not used in these cases was, apparently, the custom of working without them. So long as work is presented by hand to grinding wheels, accidents due to contact with the wheel appear to be inevitable, although it is considered that many of the initial slips and stumbles which lead to accidents could be eliminated by good floor conditions (such as non-slip surfaces, freedom from piece parts and other loose material, debris, etc.) together with good lighting suited to the work. On the whole, the standard of guarding to minimize risk of contact was good, but the adjustment of toolrests left much to be desired. Accidents in which fingers are trapped between rest and wheel almost always result in severe injury or mutilation. Frequently, the initial cause is a slip or stumble which throws the fingers on to the wheel; the fingers are then carried down into the unyielding gap between the wheel and the rest. The injury sustained there is likely to be far more severe than any resulting from the initial slip against the wheel. To prevent this type of accident, the workrest must be readily adjustable for wheel wear, and it must be kept in such close adjustment to the wheel that it is impossible for any part of the finger to enter the gap.

There is little doubt that all the 235 cases of eye injury would have been prevented by the use of suitable goggles.

Many of the 189 accidents due to projection of the work by the wheel could have been avoided by the use of suitable holders for the work. In some cases the operators were exerting unnecessary force, with the result that the wheel took control and threw the work. Accidents due to this cause call for more careful training and better supervision.

By virtue of the Dangerous Occurrences (Notification) Regulations, 1947, the burst of an abrasive wheel is notifiable even if no injury results. During the year, the number of cases notified in which abrasive wheels (excluding low-speed wheels on fixed cutting-off machines) burst was 184, and in 119 of those cases injury was caused. One hundred and forty-two bursts, including 81 cases of injury, occurred on fixed machines, while 42 bursts, including 37 cases of injury and 1 death, occurred on portable machines.

On fixed machines, no guard was in use in 13 cases of bursts, while in 8 cases the guard broke and failed to contain the fragments. Where guards were provided they enclosed the wheel reasonably well, leaving exposed only that part of the wheel necessarily exposed for the presentation and manipulation of the work, but so long as there is an opening of any size in the guard a fragment of broken wheel can escape through it and cause severe injury; a reduction in the number of injuries can thus only be ensured by a reduction in the number of bursts. The 13 cases where no guard was in use showed that there were still occupiers and workers who did not yet realize the damage that can be caused by the fragments of a burst wheel. In some cases there were difficulties in the way of providing a guard but no attempts had been made by, for example, using tapered wheels and tapered safety flanges to prevent the fragments breaking loose in the event of a wheel bursting. In several instances in which wheels burst without causing injury, the fragments had been effectively held in position by the wedging effect of the flanges. Tapered wheels are readily available from wheel makers, and should be used wherever it is not possible to provide a guard which will prevent injury from

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flying fragments. Eight accidents occurred because the guard was unable to withstand the force of the bursting wheels. In these cases, the guards were made of cast iron, cast aluminium and similar brittle materials. Experience has shown that such materials are unsuitable for any but the smallest and lightest wheels. The effectiveness of a guard is not tested until the wheel bursts, therefore no risk should be taken in respect of either the nature of the guard material or the strength of the scantlings and anchorages, since misjudgment in such matters may bring disastrous results.

The causes of the wheel bursts varied; of the 142 which occurred on fixed machines, 42 were due to rough or otherwise incorrect usage, 32 to faulty storage and incorrect mounting, 21 to jamming of the wheel, and 10 to over-speeding; 10 bursts occurred while the wheels were being dressed and 27 were unexplained.

Among the cases of rough or incorrect usage, there were cases of gross abuse. For instance, fine tool-grinding wheels were used for rough heavy work, and heavy side-grinding was done on unsuitable wheels. In other cases, an incorrect type of wheel had been chosen for the material being ground, so that inefficient cutting resulted and the operator, in an effort to improve matters, used undue force and wrecked the wheel. In the case of bursts due to faulty storage and incorrect mounting, the wheel invariably broke up as soon as it was started after mounting. Frequently, insufficient regard is paid to proper storage conditions, the relatively fragile nature of abrasive wheels receiving little consideration. In one instance, two large vitrified wheels were sent from one factory to another loosely packed together in a box. One wheel disintegrated as soon as it was started after mounting. Subsequent investigation showed that the wheel had been cracked in transit, an occurrence which was almost inevitable in the absence of proper packing. After the occurrence, the other wheel was examined and was also found to be cracked. Careful inspection, both visually and by tapping to produce a ringing sound, is an essential precaution to be observed before any wheel is mounted. Investigation of other accidents within this category revealed gross carelessness, such as dropping wheels during handling, leaving wheels lying on the floor, and keeping wheels in tool boxes where they were subject to jostling against spanners and the like.

Faulty mounting was the direct cause of many bursts, wheels being mounted in some instances between flanges of unequal or insufficient diameter, or even between plain steel washers. Even where correct flanges were used, there were cases of over-tightening, causing the wheel to crack.

Jamming of wheels occurred when the wheel became caught in a recess in the work or when the work entered the space between the wheel and the workrest. Only greater care by operators can overcome the first-mentioned risk, although managements can sometimes help by providing a wheel of appropriate thickness for the work. The risk of work jamming between the wheel and workrest is very real, but danger may be avoided if the workrest is provided with an adjustment for wheel-wear and if the worker keeps the rest adjusted as near as possible to the wheel face or side, as the case may be.

The 10 wheel-bursts due to overspeeding were all primarily attributable to failure to ascertain whether the wheel was suitable for rotation at the speed of the spindle on which it was about to be mounted. In one such case, a wheel lying on the floor was immediately mounted on a spindle without any enquiry about its safe working speed and the speed of the spindle. As soon as the wheel was started up, it disintegrated, and subsequent investigation showed that it was of a type quite unsuitable for the spindle speed. In any case, it was bad practice to use, without competent examination, a wheel

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found "lying about", however low the speed of the spindle. The bursting of 27 wheels due to causes which could not be ascertained even after careful examination of the fragments by the makers is sufficient confirmation that an abrasive wheel is a potential hazard, even after every precaution has been taken, both in the course of manufacture, and by testing, proper storage, efficient mounting and careful use. The wheel should therefore be so guarded that it is enclosed to the greatest possible extent. Where the nature of the work precludes reasonable enclosure, suitably mounted tapered wheels should be used.

Abrasive wheels on portable machines are too often allowed to run completely unguarded, under the pretext of impracticability, although in many cases guards could have been used. Frequently, the extent of the enclosure cannot be as great as on fixed machines, but this disadvantage may be lessened by the fact that the operator can usually keep the guard between himself and the wheel. As in the case of fixed machines, the use of safety tapered wheels and flanges on portable machines would substantially reduce the number of injuries.

Of the 42 bursts on portable wheels, no guard was provided in 24 cases and in one case the guard broke and was unable to contain the fragments; 11 of the cases were due to overspeeding; faulty storage or incorrect mounting was responsible in another 11 cases; rough or incorrect usage occurred in 10 cases; 3 cases were due to jamming of wheels; a faulty method of dressing the wheel caused 1 burst, while in 6 cases the causes of bursting were unexplained.

Overspeeding of portable wheels is becoming increasingly common, and is largely due either to low-speed wheels being mounted on high-speed spindles or to excessive speeds of air-driven machines due to governor defects. To avoid governor defects, regular maintenance in accordance with the instructions of the machine maker is essential, but in no circumstances should repairs or adjustments be undertaken by a person who is not qualified and experienced. Operators should be encouraged to report at once any apparent variation in speeds of these machines, as this may well be the first symptom of a governor defect.

Early in 1956, a draft code of Special Regulations was prepared, entitled The Fencing of Abrasive Wheels Special Regulations, 1956.

Hydro-Extractors and Centrifuges

The number of hydro-extractor accidents showed an appreciable reduction on that for the preceding year, there being a total of 27 accidents, a reduction of 12. There were no fatalities. Nine of the accidents occurred in chemical works, 6 in laundries (as against 18 in 1954) and 3 in textile works, while the remaining 9 occurred in a variety of industries such as sugar-refining, engineering, etc. The causes of the accidents were as follows, the corresponding figures for the preceding year being also shown together with their distribution according to trade:

Accident Causation	*1954*	*1955*
Basket and machine failures	11[2]	6
Trap between basket and lid	4	—
Entanglement with contents	4[1]	2
Contact with rotating basket, etc.	6	7
Fouling of plough, spade, etc.	3	2
Cover falling, etc., and striking person	6	5
Other	5	5
	39[3]	27

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Classification by trade		
Laundries	18[2]	6
Chemical works, etc.	8[1]	9
Textile works, etc.	4	3
Other	9	9
	39[3]	27

Raised figures indicate fatal accidents (included in lower figures).

Power Presses

The number of tool and die accidents on crank-type power presses was 292, which is one in excess of the figure for the previous year but 47 more than the number in 1953. The present figure is little different from that for 1952, when for the first time the number of crank-type power press accidents fell below the 300 level. Over the past four years, therefore, with the exception of 1953, the number of power press accidents has scarcely varied. The figures for 1947 to 1955 are shown in Fig. 8.

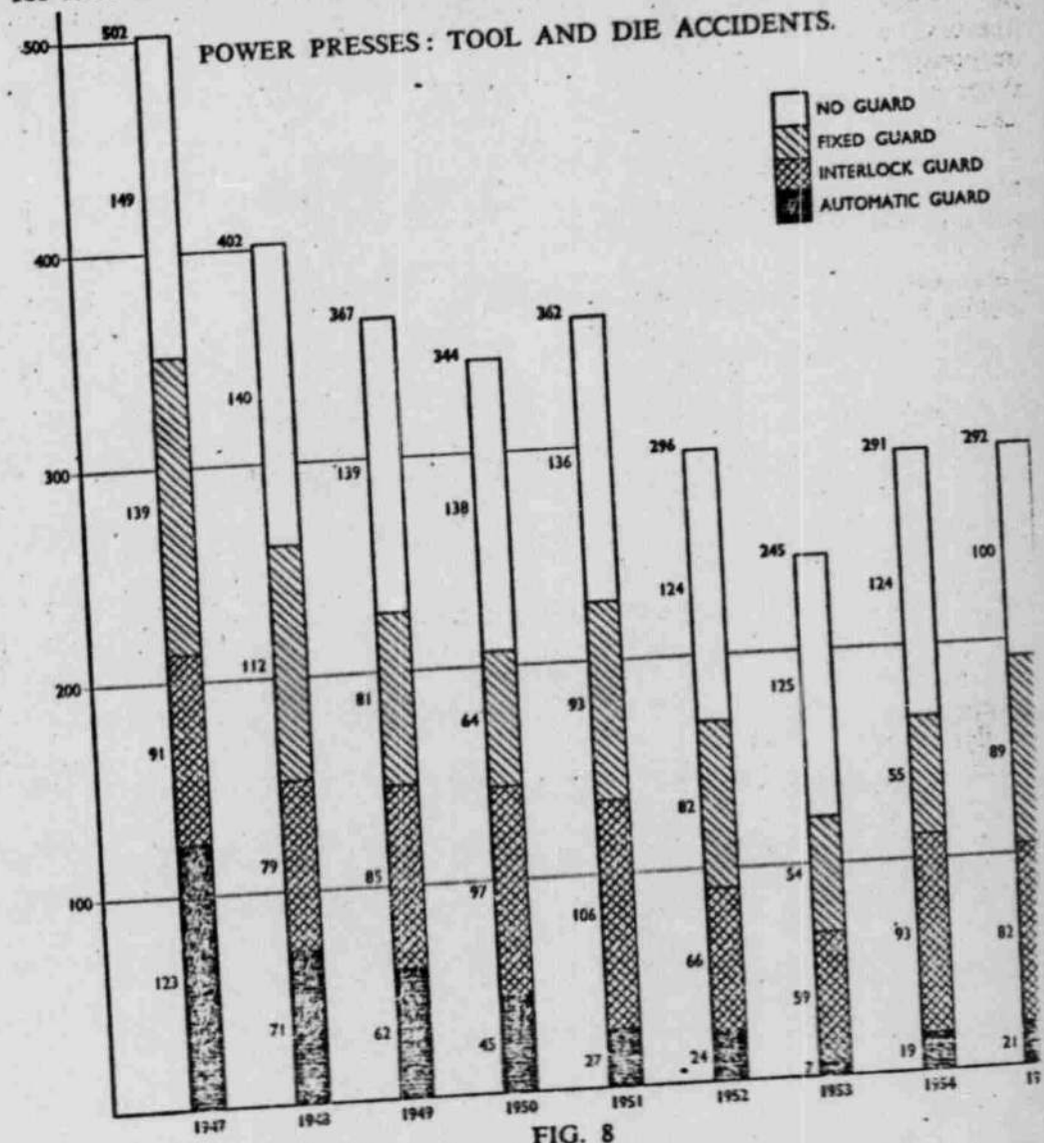


FIG. 8

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While it is not to be expected that reductions of the magnitude achieved during the period 1947 to 1952 could continue, the fact that in 1955 accidents are still practically at the 1952 level calls for serious consideration. That an improvement can be brought about is indicated by the low figure of 245 achieved in 1953 and, while press and guard designers have an important role to play in making this class of machine safer, the analysis of the accidents which occurred during 1955, shown in Table 12, points to the need for the user to take more effective measures to ensure the safe working of these machines.

TABLE 12

TOOL AND DIE ACCIDENTS ON CRANK PRESSES:
ANALYSIS BY TYPE OF GUARD

Type of Guard in Use	No. of Accidents
Automatic	21
Interlocking	82
Fixed	89
No guard in use	100
Total ...	292

Presses fitted with automatic guards were involved in 21 accidents in 1955, by comparison with 19 in 1954, 7 in 1953 and 24 in 1952. The limitations on the use of an automatic guard are not everywhere understood. The fact that an automatic guard is intended merely to remove the operator's hands to a safe position when danger threatens limits the effective use of such a guard to cases where the hand cannot become trapped before the guard action is complete. Not only must that condition be satisfied — and specific recommendations in the matter are contained in the Report of the Committee on Safety in the Use of Power Presses — but the guard must be maintained at the acme of efficiency, for if the margin of safety is reduced the guard may not protect the operator against the consequences of some unusual act on his part.

Accidents on presses fitted with fixed guards increased from 55 in 1954 to 89 in 1955. That there was a substantial decrease in the number of accidents at machines on which no guard was in use is a step in the right direction, but an inefficient fixed guard may be little better than no guard at all in circumstances which give rise to accidents. It is not sufficient that a fixed guard should prevent only accidental approach to the danger zone; until it is universally realized that deliberate access to the tools must be prevented, accidents with fixed guards will continue to occur.

In 1955, 82 accidents occurred in which interlocking guards were involved, a reduction of 11 in the figure for 1954. Of these accidents, 70 were due to failure of the guards, for reasons such as wear, inadequate maintenance, etc., to afford the measure of safety provided for in the design, 5 were due to the development of press defects against which the guards could not afford any protection, while in 7 cases the guards were of faulty design.

Accidents on press brakes numbered 26, as against 13 which occurred during 1954. Although guards are being fitted to more of these machines, the number of machines in use is also increasing rapidly.

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There were 3 accidents on friction screw presses in the course of 1955 as against 7 in 1954.

Hydraulic press accidents have increased from 76 in 1954 to 91 in 1955, practically the whole of this increase being attributable to the plastics industry. Of the 45 accidents in this industry, 37 occurred at injection moulding machines. In addition to the 91 hydraulic press accidents, 21 accidents occurred on pneumatic presses. The dangers of these machines are similar to those of hydraulic presses, and the means of protection are designed along similar lines.

Die-casting machine accidents totalled 67, as against 53 in the previous year. Twelve of these accidents were due to trapping between the dies, 19 were due to contact with other moving parts, while 6 were due to burns other than those caused by metal-splash as the dies closed. As in previous years, the greatest number of accidents were caused by molten metal forced out as the dies closed, 30 persons sustaining injuries in this way.

Presses used for baling scrap or waste materials such as paper, shavings, sheet metal trimmings, etc., create a very serious risk when the platen moves into the box in which the loose material is compressed to form a compact bale. The machines may be either mechanically or hydraulically operated, and in most cases the provision of orthodox fencing which would positively prevent an accident is impracticable. Progress is, however, being made; the line of attack is to render the machine safe to the operator by removing him from within reach of the point of danger, and to provide him with an unrestricted view so that he can see whether anyone is endangered before he sets the machine in motion. During 1955, 46 accidents occurred at baling machines, 23 occurring during the baling of waste paper.

The principal activity of the Joint Standing Committee on Power Presses was the preparation of the Third Report of Proceedings.

In view of the increase in the number of presses of moderate size actuated through friction clutches, the Joint Standing Committee decided to set up a Sub-Committee to study methods of control of friction-clutch operated presses. This Sub-Committee, on which press-makers, press-users, guard makers and the Department are represented, considered recommendations for compressed-air equipment and compressed-air control on presses. The Sub-Committee then commenced a study of electrical matters affecting the safety of presses. The Sub-Committee had the advantage of having the Vice-President of a large American corporation present at one of its meetings, when the Sub-Committee was informed about the practice in the U.S.A. on the matters under consideration.

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CHAPTER 7

Electrical Accidents

TOTAL REPORTABLE ELECTRICAL ACCIDENTS

ELECTRICAL accidents reported* under the Factories Act, 1937, during 1955, numbered 739, of which 42 were fatal. The variation in total accidents over a twenty-year period is shown in Table 13. It will be seen that the totals have remained fairly steady for the last ten years, in spite of increasing employment and very greatly increased use of electricity.

TABLE 13

REPORTABLE ELECTRICAL ACCIDENTS, 1936-1955

Year	Fatalities	Total Accidents
1936 ...	31	520
1937 ...	36	583
1938 ...	30	560
1939 ...	No records due to commencement of hostilities	
1940 ...	32	729
1941 ...	51	921
1942 ...	51	1,042
1943 ...	58	1,255
1944 ...	31	1,072
1945 ...	31	891
1946 ...	33	769
1947 ...	30	734
1948 ...	43	780
1949 ...	24	771
1950 ...	38	778
1951 ...	34	715
1952 ...	38	721
1953 ...	40	744
1954 ...	33	707
1955 ...	42	739

One hundred and forty-four dangerous occurrences were notified in 1955, under S.R. & O. No. 31, 1947,** compared with 113 in the previous year.

FATAL ACCIDENTS

In 1955, in addition to the 42 fatal accidents reported under the Factories Acts, a further 100 electrical fatalities in places outside the scope of the Acts came unofficially to the notice of the Department, the total known electrical fatalities being 142. The numbers of known fatal electrical accidents during the past twenty years are set out in Table 14.

*Under the Factories Act, 1937, an accident is not reportable unless the person is disabled for more than three days from earning full wages at the work at which he was employed.

**This requires written notice to be sent to the Inspector for the District of (among others) the following classes of occurrence:

"Electrical short-circuit or failure of electrical machinery, plant or apparatus, attended by explosion or fire or causing structural damage thereto, and involving its stoppage or disuse for not less than five hours;

Explosion or fire affecting any room in which persons are employed and causing complete suspension of ordinary work therein for not less than twenty-four hours."

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TABLE 14

FATAL ELECTRICAL ACCIDENTS, 1936-1955

Year	Domestic or similar premises		Industrial or similar premises		Total
	Domestic	Miscellaneous	Factories	Miscellaneous	
1936 ...	28	7	31	46	112
1937 ...	22	11	36	37	106
1938 ...	32	18	30	47	127
1939 ...	No records due to commencement of hostilities.				
1940 ...	52	15	32	51	150
1941 ...	49	12	51	58	170
1942 ...	61	13	51	56	181
1943 ...	44	12	58	51	165
1944 ...	37	27	31	59	154
1945 ...	48	24	31	75	178
1946 ...	36	29	33	48	146
1947 ...	40	26	30	29	125
1948 ...	49	19	43	36	147
1949 ...	54	16	24	35	129
1950 ...	44	6	38	36	124
1951 ...	39	4	34	30	107
1952 ...	52	4	38	42	136
1953 ...	45	1	40	40	126
1954 ...	51	1	33	37	122
1955 ...	39	2	42	59	142

Pressure and System of Supply

The distribution of the fatal accidents among the different supply pressures is given in Table 15, and it will be seen that the greatest number of fatalities occurred at pressures not exceeding 250 volts.

Many people, including some electricians, still assume that the risk at this voltage is negligible.

TABLE 15

REPORTABLE ELECTRICAL FATALITIES: ANALYSIS BY PRESSURE, 1955

System	Accident Pressure Volts	Fatalities
A.C. ...	Over 10,000	2
A.C. ...	5,001 to 10,000	6
A.C. ...	651 to 5,000	2
A.C. ...	251 to 650	7
A.C. ...	Up to 250	25

ANALYSIS OF ELECTRICAL ACCIDENTS

The distribution of the accidents among the various grades of skilled and unskilled persons is given in Table 16. It will be seen that skilled workers and, in particular, electricians, are by no means immune from accidents.

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TABLE 16

REPORTABLE ELECTRICAL ACCIDENTS: ANALYSIS BY EMPLOYMENT, 1955

Occupation	Fatal	Non-Fatal	Total
Skilled:			
Supervisory staff	2	26	28
Switchboard and sub-station attendants ...	–	8	8
Testing staff	–	11	11
Electricians, jointers, etc.	8	177	185
•Fitters, erectors, etc.	6	59	65
Unskilled:			
Crane drivers	–	14	14
Other trades and grades:			
(1) Men	22	191	213
(2) Male workers under 21	4	52	56
(3) Women	–	24	24
(4) Female workers under 21	–	7	7
Cases of eye-flash from electric welding, unclassified as to occupation	–	128	128
Total	42	697	739

• Degree of skill not recorded.

Table 17 shows the numbers of accidents which were associated with different types of equipment. These figures do not differ materially from those of the previous year. Attention is again drawn to the high proportion of accidents which arises from the use of portable electrical equipment. The proportions for the past three years are given in Table 18. From year to year in this Report it has been emphasized that if lower voltages were more generally adopted for portable and transportable equipment the number of accidents and, in particular, the number of fatalities, would be very substantially reduced.

ACCIDENTS WHILE TESTING

The term "testing" covers a number of activities varying from the work in a high-tension laboratory to that of a maintenance electrician who is tracing a fault in a motor starter with a voltmeter or with lamp and leads. As usual, a number of accidents arose from working on live medium-voltage circuits. Several accidents occurred while disconnecting live equipment, either because a contactor had failed to open or because the tester had forgotten to open the switch. One man received a high-voltage shock because of an internal breakdown in an instrument.

The following are a few typical examples:

A woman assembler entered a test department to see the chief tester and inadvertently touched a cable undergoing a 6·5-kV test; a flashover occurred and she was burned, but received no noticeable shock as the circuit was not earthed.

A tester, aged 29, forgot to switch over before disconnecting the test leads.

An apprentice winder, aged 20, picked up live testing leads; the push-button-controlled contactor had frozen-in and he neglected to use the isolator available.

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A student apprentice, aged 21, mistakenly attempted to disconnect a liv 460-volt D.C. cable and was burned.

A television mechanic, aged 18, received a shock from the live chassis o a television set under test and repair.

An electrician, aged 24, caused a flashover while using an unsuitable tes lamp and leads.

TABLE 17

REPORTABLE ELECTRICAL ACCIDENTS: ANALYSIS BY APPARATUS, 195

Apparatus	FATAL		NON-FATAL		TOTAL
	Men	Women	Men	Women	
Portable apparatus:					
Portable electric machines ...	6	–	53	4	63
Portable heaters and irons ...	–	–	4	5	9
Portable lamps	2	–	9	1	12
Portable test sets including lamps, etc.	1	–	19	–	20
Plugs, sockets and adaptors ...	3	–	33	1	37
Cables and flex for portables ...	6	–	25	2	33
Electric hand welding:					
(a) Shock and/or burns ...	1	–	18	–	19
(b) Eye injuries	–	–	128		128
Fixed apparatus:					
Electrical machines	–	–	13	2	15
Transformers	1	–	1	–	2
Switchgear above 650 volts:					
(a) Switchboards	3	–	48	–	51
(b) Motor or other control apparatus	–	–	1	–	1
Switchgear below 650 volts:					
(a) Switchboards	1	–	64	–	65
(b) Motor or other control apparatus	1	–	50	2	53
Fusegear	–	–	28	–	28
Crane trolleys and collectors ...	6	–	36	–	42
Fixed lamps	1	–	17	2	20
Cables for fixed apparatus ...	4	–	78	4	86
Test leads	–	–	18	3	21
Overhead transmission and distribution lines:					
(a) Contact by cranes or similar machines	4	–	2	–	6
(b) Direct contact or contact through materials handled	1	–	7	–	8
Apparatus not classified	1	–	14	5	20
Total	42	–	538	31	739
			Plus 128 eye-flash accidents (welding).		

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TABLE 18

ACCIDENTS ON PORTABLE APPARATUS, 1953–1955
(including the associated plugs, sockets and flexible cables)

	1955	1954	1953
Fatal accidents due to portable apparatus ...	19	15	16
Ditto as percentage of total electrical fatalities	45	45	40
All accidents (excluding welding eye-flash) due to portable apparatus	193	194	204
Ditto as percentage of total electrical accidents (excluding welding eye-flash)	32	35	35

NATURE OF INJURIES

The number of electrical accidents in 1955 involving electric shock, with or without the accompaniment of burns, was 341. The number of electrical accidents involving burns, with or without shock, was 401. The number of accidents involving shock and burn together was 131.

The 341 accidents involving electric shock included 100 which caused a fall, and in many of these cases the fall resulted in more serious injury than did the shock itself. When there is no fall or other injury, a man who receives a non-fatal electric shock usually recovers completely in a few hours, or at the most after a day or two, and the accident is not then reportable, even though he may have been unconscious and revived by artificial respiration.

OVERHEAD LINES

There have again been several fatal and many non-fatal accidents due to accidental contact with the high-voltage and medium-voltage overhead distribution lines of Area Boards. Not all of these accidents were reportable under the Factories Acts; those which were so reportable occurred on factory premises, building operations and works of engineering construction. The Central Electricity Authority and the Area Boards have done much to try to prevent this type of overhead line accident. Patrol linesmen and other members of the staffs of Area Boards discover, in the course of their work, some of the operations in which risk from overhead lines may be incurred, but, of course, only a small proportion of the activities likely to involve danger can be covered in this way.

Danger notices are, however, often looked upon merely as attempts by the Central Authority and the Area Boards to dissuade small boys from climbing poles, and are considered to be of no consequence to their elders.

Failure to appreciate the risk appears in particular in the course of small building operations, and it is probably in this direction that publicity of the dangers would now be valuable. The following two incidents happened within the space of a few weeks within a radius of 15 miles, and caused the deaths of three men.

A bungalow was being built on a plot of land over which passed a single-phase 11-kV overhead line. Steel scaffolding was required for the gable-end. The scaffold uprights were being erected at a point 1 ft. 3 in. from the vertical under one of the live conductors. Two steel poles, each 16 ft. long, had been put up without incident. The two men concerned then selected a 23-ft. pole from a pile nearby and were pushing it upright when it made contact with the conductor. One man, who had positioned his foot to steady the pole and who was helping to pull it upright and towards him, died immediately. The

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other man, who was pushing from the opposite side, received a severe electric shock and was badly burned on both hands and feet.

A mobile crane was being used during the course of laying a new 18 in. water-main along a country road over which crossed a 6·6-kV single-phase overhead line. The driver, assisted by two men, had manoeuvred his vehicle under the line in order to lift a section of piping from the grass verge on to some baulks placed ready to receive it. Realizing the danger from fouling the conductors by the jib of the crane, one of the men had been detailed to act as banksman and to warn the driver if he appeared to be approaching too near the line. As the jib was being elevated to position the pipe, the latter commenced to swing and the banksman ran forward to assist his mate to control the load by hauling on the lifting chains. None of the men was therefore watching the line and the driver continued to elevate the jib, which eventually made contact with one of the conductors. The two men holding the chains were immediately electrocuted.

These two accidents illustrate the lack of care often found in such circumstances, and it is clear that the serious hazards were not fully appreciated by the people concerned. The attention of factory occupiers, builders and contractors is constantly being drawn to these dangers and, under the terms of Regulation 2 of the Electricity Regulations, it is necessary to ensure that overhead lines are efficiently protected or so placed and safeguarded as to prevent danger. Where the lines of the Central Electricity Authority or the Area Boards are encountered, arrangements should be made to delimit the working area, by fencing or other means, in order to prevent the jibs of cranes or similar vehicles from approaching to within a dangerous distance of the conductors. In many cases, it may be found advisable to divert the line or to place it underground. In other cases it may be possible to make the line dead for a specific period so that the work may be carried out quickly and safely.

ARTIFICIAL RESPIRATION IN CASES OF ELECTRIC SHOCK

It is of the greatest importance that artificial respiration be started at once and continued for at least an hour, preferably for two hours. Even if a medical practitioner states that life is extinct, continued artificial respiration can do no harm and there are several cases on record where the victim's co-workers have persisted in spite of such advice and have eventually succeeded in resuscitating him.

The records for 1955 may be summarized as follows. Of 60 persons known to have been unconscious, 5 had fractured skulls or similar injuries, 15 received no artificial respiration and died, and of the remainder, who received attention, 19 recovered and 21 died.

In most cases where artificial respiration was applied it was started fairly promptly, though sometimes there were delays of five, ten and fifteen minutes. In one or two instances there was some delay, for example, when a man who had been welding in the double bottom of a ship was not found for some time. In other cases, there was inevitably delay in moving the patient before any first aid could be started, and it is possible that at least one or two of these men could have been saved if artificial respiration could have been applied promptly.

Artificial respiration was in most cases continued only for a short period. Ten persons recovered in less than five minutes, 2 in five to ten minutes, 2 in about fifteen minutes, 1 in twenty minutes and 2 in thirty minutes. In only 6

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cases was artificial respiration continued for twenty to thirty minutes and in only one case for more than thirty minutes, but as in this instance there had been an hour's delay in starting, there cannot have been much hope.

The circumstances of certain cases are of interest in showing the different degrees of assistance afforded:

A man working with an electric hammer, which he was using as a concrete vibrator in wet conditions, received a shock from a damaged flexible cable and fell unconscious. Artificial respiration was applied immediately by another employee who had had previous experience in this treatment and the unconscious man revived after ten minutes.

A fitter received a severe electric shock from a portable drill after he had incorrectly re-wired a plug to the three-core flexible cable, and was rendered unconscious. One of his colleagues remembered where the Electric Shock Placard was located, procured it, and immediately commenced treatment, being guided by the illustrations and instructions thereon. The injured man regained consciousness after about twenty minutes' application and suffered no permanent injuries.

In an accident in which two men were killed, some form of artificial respiration was attempted, but the operators had no previous knowledge of or experience in the method.

A somewhat peculiar interpretation was given to the phrase "Keep Cool" on the Electric Shock Placard issued by one group of publishing firms. The phrase was taken as referring to the patient. An electric shock victim was, therefore, carried out of a warm workroom and placed on the cold concrete floor in the open air. The publishing firms subsequently issued a revised placard, which is now in general use.

CHAPTER 8

Fires and Explosions

Inflammable Liquids

IN MY REPORTS for 1953 and 1954, tables were published showing an analysis of the various types of accident due to inflammable liquids. An analysis of this kind was not made in 1955 but it is clear that the relative frequency of the various types of accident did not differ greatly from the relative frequency in previous years. It was felt that sufficient statistical information was now available; the problem of assessing what reasonable steps could be taken to effect any appreciable reduction in the number of these accidents was studied more closely.

A great deal could be achieved by comparatively simple precautions if the dangers associated with inflammable liquids were more clearly understood by both management and workers. It is, however, first necessary to know whether the liquids kept or used are in fact inflammable and, if so, how inflammable. One of the difficulties is that, according to the Petroleum (Consolidation) Act, 1928, the containers for a limited number of the more volatile inflammable liquids have to be marked "Petroleum Spirit, Highly

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Inflammable" or "Petroleum Mixture giving off an Inflammable Heavy Vapour", whereas many equally dangerous liquids can legally be sold and kept in containers without any warning mark. An improvement in this position is likely to take place as a result of the scheme for container-marking introduced by the Association of British Chemical Manufacturers.

If a liquid is used at a temperature above that defined as the "flash-point", there is a risk that an explosive concentration of vapour may build up in any closed or insufficiently ventilated space in which the liquid is present. An explosion can then occur if any source of ignition is present or is introduced.

In at least two instances during the year, an Inspector was able to show, by a very simple test, that liquids in use in factories were highly inflammable at ordinary temperatures, in spite of the occupiers' assurances, given no doubt in good faith, that the liquids were non-inflammable and quite safe. The test, which was done in each case in a safe place in the open air, was to pour just enough of the liquid into a small open-topped tin (a one-pound syrup tin) to cover the bottom of the tin, to place a piece of cardboard over the tin to act as a loose lid and then, after a short interval, to move the cardboard slightly to one side and to insert a lighted taper into the air space in the tin. The resulting flash of flame due to vapour given off from the liquid was quite sufficient in each case to convince the occupier that he was mistaken. Flash-points are, of course, determined in an apparatus such as the Abel flash-point apparatus, which, although it has many refinements, is basically the same as the simple apparatus described above, except that the Abel apparatus has a water-bath to warm the liquid under test and thus to enable the minimum temperature to be ascertained at which the liquid will give off sufficient vapour to "flash" or explode if a source of ignition is applied.

Once the user of a highly inflammable liquid, whether it be the pure liquid or a solvent in an adhesive, paint or other mixture, has had the vapour risk demonstrated to him, either by experiment or by sad experience, he begins to appreciate the importance of the elimination of obvious sources of ignition such as coke stoves, gas fires, electric heaters, and so on. A typical case, in which experience was the teacher, occurred in a factory in which wax moulds were made for castings. A worker accidentally knocked over a bucket containing about half a gallon of acetone. The bucket was on the floor within a few feet of a gas-heated radiator. The acetone spread towards the radiator and the vapour ignited. A 15-year-old girl who was standing near to the radiator was burned.

Reports of many similar accidents could be quoted in which details are given of work done with highly inflammable liquids in close proximity to obvious sources of ignition. In workrooms where the Cellulose Solutions Regulations apply, there is a requirement that "No fire, flame, open light or other agency likely to ignite cellulose solutions or inflammable liquids or the vapours thereof shall be allowed within 20 ft. of any cellulose cabinet, cellulose space or store room, unless effectively separated therefrom by means of intervening fire resisting material". (An inflammable liquid, for the purposes of these Regulations, is one with a flash-point of less than 90°F.) This particular Regulation has, legally, limited application, but it is a useful rule which, if properly applied to the multitude of industrial processes in which inflammable liquids are used in reasonably small quantities, would raise the standard of safety considerably. It is realized that a distance of 20 ft. would be inadequate in some instances. Such a distance would, however, rarely be excessive. The ideal is, of course, complete isolation of the process involving

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the inflammable liquid by means of a building or room specially designed for the purpose.

In the above-mentioned accidents not only were the inflammable liquids used near to sources of ignition but also they were in unsuitable containers. Several types of container specially made for inflammable liquids are available and it is usually not difficult to design a suitable inflammable-liquid container for a particular purpose if the normal types are, for any reason, unsatisfactory. The containers should be reasonably secure against accidental breakage, unlikely to cause spillage, and so constructed that the minimum surface area of the liquid is exposed. In those containers, such as dip-tanks, in which it may not be practicable to restrict the surface area, the provision of hinged lids arranged to close automatically by the action of a fusible link is, in general, good practice.

Where, because of the nature of the process, spillage or leakage of liquid is a possibility, simple precautions to limit and control the flow of the spilt liquid can often be introduced without difficulty. Such precautions would prevent a number of serious accidents. The simplest example of such a precaution is the provision of a tray, or the construction of the top of a work-bench in the form of a tray or series of trays. Where large quantities of inflammable liquids are involved, as in solvent extraction plant, distillation plant, etc., the same principle should apply; failure of a process vessel or of the attached fittings does not happen very frequently but disastrous explosions and fires can follow when such failures do occur unless arrangements have been made, by means of sills, moundings, drainage, etc., to prevent the liquid from spreading.

As stated above, if a liquid is at a temperature higher than its flash-point an explosive concentration of vapour may build up in any enclosed or insufficiently ventilated space in which the liquid is present. Such spaces should either be abolished or adequately ventilated. During 1955, as in previous years, there were several explosions in garage inspection pits. For example, a mechanic drained about three gallons of petrol from the tank of a car into a drum while the car was standing over an inspection pit. Next day, he entered the pit and had just completed some welding on the under-side of the car when there was an explosion in the pit. His face and arms were burned. A car-lift is now used in this garage to raise cars above ground level when such work is done under them, and thus the risk of accumulation of explosive vapour in a pit is avoided.

Explosive concentrations of vapours from inflammable liquids having flash-points above room temperature can, of course, form if the liquids are heated and the vapours given off are not diluted and removed as they are given off, by an adequate flow of fresh air. The risk of explosion in ovens and drying machines is found to be rather greater with these high flash-point liquids than with low flash-point liquids, probably because work wet with the more volatile liquid is likely to be drier before it reaches the oven or drying machine. In the dry-cleaning industry, the use of petrol and similar solvents of low flash-point is prohibited by the Regulations of 1949, and the risk of a serious burning accident at the washing stage has thereby been almost eliminated. The drying stage is, however, another matter, for in the drying machines temperatures of 150°F. are quite normal, so that an explosive mixture of white spirit vapour and air can be formed. It is thus absolutely imperative that the concentration of white spirit vapour be kept well below the lower explosive limit (about 0·9% by volume). Little has been known hitherto of the actual conditions inside a tumbler during the drying operation,

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and without such knowledge, recommendations to secure safety could only be tentative. The Dyers' and Cleaners' Research Organization has, however, recently finished a study of this problem, and has circulated a series of most informative and helpful technical pamphlets containing recommendations as to precautions against explosions. The main precautions to be observed are first, the extraction, as thorough as possible, of white spirit from the goods before they go to the drying tumbler, and second, the maintenance of a sufficient velocity of air through the drying tumbler to keep the concentration of white spirit vapour well below the inflammable range.

To ensure the thorough extraction of spirit, the efficiency of the hydro-extractor must be maintained. Dry-cleaning firms are urged to check the efficiency of their hydro-extractors at regular intervals. This can be done since the amount of white spirit retained by typical loads can be determined experimentally. The makers of drying tumblers can be relied upon to design and sell machines which have a through-put of air adequate to prevent any risk of explosion provided the machines are properly installed and maintained. Invariably, when an explosion occurs, it is found that the makers' air-speeds have been substantially lowered by bad installation, by the choking of lint screens, or by some other factor under the control of the user.

A rough but useful rule, in connection with the dilution of vapours from inflammable liquids in general, is that about 1,200 cubic feet of fresh air (measured at room temperature and pressure) should be used to dilute the vapours from the evaporation of one pint (or one pound) of liquid.

Apart from ventilation, an important precaution against explosions in ovens and drying machines is the provision of adequate explosion reliefs. A paper by Cubbage and Simmonds entitled "An Investigation of Explosion Reliefs for Industrial Drying Ovens"* which was presented to the Autumn Research Meeting of the Institution of Gas Engineers gives a great deal of information of value when explosion reliefs for venting explosions due to solvent vapours are being designed.

A frequent cause of accidents is the addition of waste inflammable liquids to heating stoves, boilers, etc. Disposal of such waste material is often difficult. Where the quantities involved are large, recovery by distillation may be worth while and there are a few firms which specialize in such work. Generally, however, the quantities are small and there is a temptation to throw the residues for disposal into the combustion chamber of the factory boiler or into a stove. Many explosions and serious "flash-backs" have occurred when this has been done. If burning is the only possible means of disposal, the use of a properly designed burner should be considered, or, failing that, shallow trays may be used in a safe place in the open air. In several instances it has been found, after discussion, that slight alterations in a process or method of working reduced the amount of waste inflammable liquid.

Previous Reports have stressed the dangers arising when heat is applied, for welding, soldering, cutting, etc., to drums, tanks and similar vessels which have contained inflammable liquids but which appear to be empty. During 1955, there were several explosions of "empty" drums used as work-benches to support welding or flame-cutting work. One of these explosions caused a fatality. An "empty" drum which has contained inflammable liquid should always be treated as a potential explosion hazard until it has been steamed or otherwise made safe.

* Copies of this paper may be obtained from the Gas Council, 1 Grosvenor Place, London, S.W.1.

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Bandages on hands or arms, or clothing, wetted with inflammable liquids again caused several serious burning accidents. The liquids were not all highly inflammable; for instance, a man handling oily materials used an apron made of sacking which became heavily impregnated with oil. The apron was set on fire while he was lighting a cigarette, and he was very severely burned.

It is difficult to make a simple code of rules covering in detail the precautions for all the various types of accidents due to inflammable liquids, but the following general principles should be observed when such liquids have to be used. The possibility of using less dangerous materials, for instance aqueous detergents instead of inflammable cleaning liquids, should, of course, always be the first consideration.

1. Make sure, by the marking of containers and by suitable instruction, that persons using inflammable liquids know the dangers associated with them.

2. Isolate work with inflammable liquids as completely as practicable from other work.

3. Separate processes involving inflammable liquids by as great a distance as possible from sources of ignition and, if practicable, separate these processes from the source of ignition by fire-resisting partitions.

4. Reduce spillage and unnecessary evaporation by the use of containers designed for the purpose, and provide trays, sills, moundings, special drainage, etc., to localize spillage or leakage if it should occur.

5. Provide adequate ventilation.

6. Instal explosion reliefs where needed, particularly on ovens and drying machines.

7. Use splash-guards or other suitable devices to prevent clothing or bandages worn by workpeople from becoming wet with inflammable liquids and in addition, if necessary, make use of protective clothing.

8. Make proper arrangements for the safe disposal of waste inflammable liquids.

9. Treat drums and other enclosed vessels that have contained inflammable liquids as dangerous until they have been steamed or otherwise made safe.

10. Provide an adequate supply of efficient fire-extinguishing appliances.

Acetylene

In 1955, the pattern of accidents with acetylene was not significantly different from that in the previous year. Three explosions in generators were reported, none of them unusual; there were two explosions when drums of carbide were being opened, and accidents in welding, cutting and burning were similar to those described in my Report for 1953.

One accident which was exceptionally severe was due to one of the few explosions of cylinders which occur each year. When a cylinder is involved in a fire or an explosion it is always a serious matter, because an acetylene cylinder contains a vast amount of energy, the gas being endothermic and able to explode at cylinder pressures in the absence of air. On rare occasions, usually after ill-treatment of some kind, a cylinder explodes and then chance alone determines whether the results are severe or trivial. A cylinder was dropped from a loading-deck to a wooden floor to be rolled on to a lorry, and it exploded at once. One man was blinded, another's leg was broken and four men sustained minor injuries and shock. Acetylene

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cylinders must be treated with great respect; if mishandled they can be very dangerous. A prevalent form of mishandling a cylinder is to expose it to violent or prolonged "backfires" when in use. A welding torch was being lit in a garage when it backfired violently and set fire to the acetylene cylinder, which exploded almost at once. A woman who happened to be passing the doorway at the time sustained a fractured skull and facial injuries.

Ammonia

It is not generally realized that, although ammonia will not burn in ordinary conditions in air, mixtures of ammonia with air in the range of 16-25% by volume of ammonia can explode. There was a spectacular ammonia explosion when the outlet manifold from one of several compressors in a large refrigerating plant in a basement fractured. As ammonia poured into the basement, most of the workers rushed out to avoid being overcome by the fumes. A few minutes later, when the concentration of ammonia had entered the explosive range, ignition occurred at a gas-ring and there was an explosion. There was surprisingly little damage in the basement itself, but ventilators were torn out and paving stones were ripped from the pavement outside and thrown through adjacent shop windows. A possible cause of the fracture was at first thought to be the "classic" one, namely that the compressor had been started with the inlet valve opened and the outlet valve shut. (The Factory Department always advises that these two valves be interlocked to prevent this, but such good practice is not yet universally adopted.) However, in this case, subsequent metallurgical examination showed that the probable cause of the fracture was that liquid ammonia had been drawn into the compressor and that the equivalent of "water-hammer", which is so well known in steam lines, had occurred in the outlet manifold, so causing the failure.

Atmosphere Furnaces

Here the term "atmosphere" is used to mean the blanket of gas that is sometimes used to surround work in a furnace, either to keep air away or to cause chemical changes in the work itself or both. By the very nature of the jobs that they have to do, "atmosphere" gases can usually combine with oxygen and are hence inflammable in air. One such gas is hydrogen, which is violently explosive in air. This gas is often conveniently produced from ammonia as "cracker-gas", which is 75% hydrogen. A firm had had a bad explosion of "cracker-gas", in which two men had been killed. This firm was therefore meticulous in the precautions taken at the atmosphere furnace itself, but, because of the small volumes involved and the isolated position of the gas-supplying apparatus, similar precautions, such as purging with an inert gas before starting, had not been applied to the system which supplied the atmosphere gas. On starting up one day, as the gas was displacing air from the system, an expansion vessel in the line exploded. This caused a loss of production (but no injury, because of the small size and position of the apparatus), so the firm decided to extend the precautions to the supply line also. In this case, the cause of ignition of the inflammable mixture in the expansion vessel was unknown and very careful investigation failed to disclose it. The system was a closed one, the gas was very clean and the flow very gentle; none of the usual sources of ignition, such as flame, electrical circuits, static electricity, pyrophoric or catalytic impurities, were likely to have been present. This incident is mentioned because it illustrates a fundamental point of safety, namely, that there is no hope of completely preventing the ignition of inflammable mixtures.

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Another explosion was of a more familiar type. A few explosions in atmosphere gas generators are notified each year, but as yet they have been relatively trivial, for a really serious explosion is not likely to occur in plant of such small size. The Factory Department, however, always treats these explosions as most serious matters, and devotes much more attention to them than their history of accidents at first sight merits. This is because an atmosphere gas generator invariably feeds much larger plant, such as a gas-holder or furnace, in which an explosion can occur if the generator goes wrong and feeds an explosive mixture instead of the atmosphere gas. In this case the explosion occurred in the dryer of a generator of partially-burnt town gas. The gas from this generator was still inflammable and it was feeding a set of large furnaces. An electrical failure in a valve on the supply of town gas caused the valve to shut. In these circumstances air alone began to be fed into the generator, which, of course, contained inflammable gas; the air was being forced into the generator via a hot combustion chamber and there was an explosion in a dryer on the generator, which wrecked the dryer. Had there been no explosion there, air would have been forced into the furnaces, where an explosion would have been disastrous. Atmosphere generators which rely on the combustion of town or similar gas should be fitted with automatic pilots (flame-failure devices) to turn off both gas and air supplies if the flame at the burner becomes extinguished. Further precautions may also be necessary: for example, if the supply of atmosphere gas were halted, air might be sucked round seals, etc., into the furnaces; thus an inert gas such as nitrogen may have to be liberated into the furnaces when the atmosphere gas is cut off.

One man was killed by an atmosphere furnace explosion. Steel was being annealed in a furnace in an atmosphere of Wellman-Galusha gas (which is similar in some respects to producer gas); the operator noticed that the gas was not coming out of the furnace at its usual rate and called the charge-hand. They had started to investigate, when there was an explosion. This furnace consisted of a bed, on which the work was placed; a cover was put over the work and the furnace proper was lowered on to the cover. The atmosphere gas was passed into the cover by a stand-pipe through the bed, and another stand-pipe carried excess gas away to burn at a bleed outside. It was found that the supply pipe had fractured under the bed, so that most of the gas was escaping elsewhere and insufficient had entered to clear all the air out of the cover. This accident illustrates once more the importance of regular and thorough maintenance. Even if an inert gas had been used in this case to purge air from the cover, this accident could still have happened because the purge gas would also have been dissipated through the break in the pipe.

The best safety measure in all atmosphere furnaces is to use a gas which is so diluted with inert gas that it cannot explode in air. This is, however, not always practicable with existing plant.

Small tubular atmosphere furnaces cause a few accidents each year, and 1955 was no exception. These furnaces are common in trades which produce the rarer metals or metals in porous or other unusual forms. The furnaces are tubes of strong construction with small cross-section and they can usually withstand an internal explosion with ease, so that they never give rise to major explosions. Accidents, of which the following is typical, can, however, occur and can be very serious for the victims. A man had withdrawn the work from such a furnace, which was working with an atmosphere of hydrogen, and he was shutting it down, when it exploded. A sheet of flame

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blew out of the end and burned him severely on the face. When a furnace of this kind is being started, or is being shut down, or when it is opened to take work from it, "blow-backs" like this are not unusual; it is just at these times that the operator's face is likely to be in the line of fire. These "blow-backs" can blind a man. Apart from the fundamental precaution of using a non-explosive atmosphere gas where possible, protection against this risk is simple: either the ends of the furnace can be shielded or otherwise fenced, or the operator can wear a visor for the relatively short time that he is obliged to be in the line of fire.

Gas-Heated Ovens and Furnaces.

For the second successive year, no one was killed by fire or explosion of fuel-gas at any gas-heated oven or furnace, but this may be due to statistical variation rather than to any improvement in safety generally. An example of an accident at an unprotected box oven in which the operator, but for good fortune, might have been killed, was due to one of the "classic" causes. The operator turned on the gas at the burner, found he had no light, so went away to get one. By the time he returned, an explosive gas/air mixture had formed, and a violent explosion occurred when he applied the light. The blast blew him against a wall, and he sustained concussion, burns and bruises. It also blew the oven doors off and wrecked the oven. Box ovens can be very dangerous and, as a general rule, ought to be protected to a high standard.

One of the protective devices which ought to be provided on every box oven, and certainly on every new box oven, is an explosion relief. If every box oven in the country had a satisfactory explosion relief, and strong door fastenings (so that the pressure vented itself through the relief, rather than by blowing open the doors), I am convinced that a fatality due to the explosion of a box oven would be such a rarity that it, rather than the absence of fatalities, would be the subject of special comment in this Report. The aforementioned paper by Cubbage and Simmonds on explosion reliefs for industrial drying ovens gives data, based on a series of experiments with full-sized plant, sufficient to enable satisfactory reliefs for the tops of ovens to be designed. Where, owing to the presence of shelves or other obstructions, top relief is not likely to be satisfactory, then relief in the back or side must be provided. The paper does not claim to give data about reliefs in positions other than the top of an oven, but, from the results obtained and from the experience gained from the study of explosions that have occurred, cautious extension of the results to the case of reliefs in positions other than the top seems justifiable. This paper marks a very decided step forward in our knowledge about the protection of ovens.

Oxygen

One accident of the several which were caused by oxygen during the year helps to illustrate the very great power of supporting combustion possessed by this gas, and hence the danger caused by leakage or misuse.

A leak occurred when an evaporator was being filled with liquid oxygen from a road-tanker. A boiler-house was nearby, and ashes there caught fire as puffs of oxygen-rich air began to drift in. The fire spread, and it was noticed that electric cables had ignited, so a man rushed in to extinguish the cable fire. A spark touched his trousers, and in that atmosphere they blazed vigorously. Fortunately, he escaped with nothing more serious than burned ankles.

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Given the right conditions, oxygen can cause violent explosions, although it is itself incombustible. The compressed-air starting-bottle of a large engine had leaked, and the attendant replaced it by an oxygen cylinder to supply the necessary pressure to turn the engine. Of course, the oil and fuel in the engine exploded, and the starting-bottle and the engine block were cracked.

Nitrate Salt Baths.

One form of heat treatment of light alloys is to immerse them in molten nitrates. Aluminium and magnesium and their alloys can, however, oxidize with the evolution of much energy. The nitrates in the salt baths are powerful oxidizing agents, so there is in this process a possibility of explosion due to violent oxidation. The process is safe under normal conditions but if the temperature of the bath rises too high an explosion becomes likely. For this reason the Departmental Memorandum on Nitrate Salt Baths (Form 848) recommends that a bath be never left unattended while there is work in it, and that an over-riding cut-out be fitted, so that if the temperature rises too high, perhaps because of the failure of the thermostat, the heating of the bath will be turned off and will not automatically be switched on again.

A disastrous explosion of a gas-heated nitrate salt bath demonstrated the wisdom of these recommendations. The bath was fitted with an electronic thermostat which had been known to give trouble, and so was not to be relied upon for safety. It controlled the temperature by opening or closing a motorized butterfly valve which would not close unless actually driven on receipt of an electrical signal from the thermostat. Thus, a failure of the electricity supply would not shut off the gas supply but would leave the valve in whatever position it happened to be when the electricity supply failed. These valves, although they have their uses, are not suitable devices to control temperature in cases in which too high a temperature is dangerous. Three hundredweight of small aluminium alloy components was left in the bath unattended, overnight. During the night, some men from an adjacent factory (the factory was on a large Trading Estate) noticed a red glow through the windows. They thought there was a fire (in fact, the glow was from the bath, which was overheating badly) so they went to summon the fire brigade. They had not gone many yards before there was a huge explosion, which wiped out the factory and damaged over a score of others on the Estate. One end of the bath was blown over a quarter of a mile, narrowly missing a full gas-holder on the way; another part penetrated a store containing gun-cotton, but did not ignite the stock in it. Fortunately, as the explosion occurred in an empty factory, no one was killed, but a man in an adjacent factory was badly injured by glass splinters from a roof.

Dust Explosions in Workrooms

In previous Reports, reference has been made to the danger that may arise in factory workrooms from the accumulation of loose inflammable dust outside the plant. Many of the worst dust explosions which have occurred in the past in the manufacturing industries were due to this cause. When the circumstances associated with these explosions are investigated, some details emerge peculiar to each explosion, but, in addition to these, one essential condition recurs with familiar regularity. Inflammable dust has been allowed to accumulate in the workroom on sills, beams, girders, machine frames and on horizontal surfaces of the plant itself. This condition may have persisted for years and may have been regarded, by both management and workmen, as a harmless and inevitable concomitant of the process. Occasionally, however,

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an incident occurs which causes the disturbance and ignition of this loose dust. The incident in itself may be trivial — a flash and a puff from a mill, unexpected friction in a conveyor, or the activity associated with the extinguishing of a fire otherwise within the control of the process workers — but the consequences of the incident may be disastrous. Some of the accumulated dust on an overhead beam may be dislodged and form a dust-cloud which becomes ignited and explodes. The shock of this explosion usually disturbs more dust and in an instant the room, or even the whole factory, is filled with an exploding dust-cloud.

The most serious explosion of this type during the year occurred at a pulverized fuel plant. In the course of his duties on a Sunday afternoon, the foreman in charge of the plant noticed that the casing of the pulverized fuel bunker was becoming hot and he suspected that fire was developing inside the bunker. He stopped the plant and made contact with the other members of the firm. Later, it was observed that there was a fire in the roof timbers of the grinder-house and the fire brigade was called. This fire was effectively extinguished by spraying the roof timbers with water and, as a further precaution, the floor of the building was sprayed, particular attention being paid to the vicinity of flues, where the temperature was high. At this stage, all apparent traces of fire in the grinder-house had been extinguished but, in the meantime, sparks had been noticed emerging from a cyclone vent above the roof, these sparks having no doubt caused the fire in the roof timbers. The bunker casing was still hot, showing that the pulverized fuel was still burning inside the plant. To remove the danger of a fresh outbreak of fire from this cause, the fuel had to be removed from the bunker. This unit of the plant was divided into three sections, the two outer ones having plug openings by means of which the fuel could be withdrawn. The inner section, however, had no such opening, and the only means of opening it was to blow the fuel forward and burn it in the kiln. This was tried, but the emission of sparks from the cyclone vent increased and the expedient had to be abandoned. In the course of normal working, a large quantity of coal dust had been allowed to accumulate on the tops of the bunker and the cyclone. This dust was now removed by shovelling it on to the grinder-house floor, which was almost thirty feet below the top of the cyclone. A considerable dust-cloud was thus caused and, while the work was proceeding, a workman noticed " a glow falling ". This was followed immediately by a dust explosion which filled the grinder-house, killed nine workmen and burned eleven other workmen and firemen (some severely).

Explosions like this are not confined to coal dust: they can happen, and have in fact happened, wherever dusts of inflammable materials such as provender, starch, dextrine, cork or certain metal powders are allowed to accumulate on workroom ledges. A full list of the dusts which have been examined and have been shown to be capable of causing dust explosions is published in Form 830*, entitled " Inflammability of Dusts ".

A much less serious explosion of a similar nature occurred when a workman, who had discharged the wood dust from a bag-filter plant serving four sanding machines, was removing the dust from the walls of the enclosure of the bag-filter. He used an electric fan for this purpose and raised a dust-cloud, which was ignited by sparks in the fan motor. The plant was wrecked by the explosion and the workman himself was severely burned. The means he used for cleaning was, of course, quite unsuitable. The best method of removing accumulations of such dust from the walls and ledges of a room is to use a vacuum cleaning plant which has been so designed as to be safe

* Obtainable from H.M. Stationery Office.

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for use with inflammable dust. On another occasion, the dust from a belt sanding machine was responsible for a minor explosion when the belt driving the machine came off the pulley, whipped round and broke a flexible metal conduit in the vicinity of an accumulation of wood dust under the machine. A flash from the broken conductor ignited a cloud of the dust that had been disturbed, and the legs and ankles of the machine operator were burned.

Dust Explosions inside Plant

As in previous years, a number of explosions occurred inside pulverized fuel plant. Many of these explosions have taken place when one of the mills serving a combustion chamber was at rest. Pressure and flame from a blow-back in the combustion chamber have passed back to the mill along the pulverized fuel pipe and caused a dust explosion in the mill and classifier. In most modern installations, the boiler-house buildings in which the mills are housed are relatively clean and free from accumulations of coal dust, and serious secondary explosions have not in recent years been caused by a primary explosion of this nature inside the plant. Nevertheless, some of the primary explosions have been sufficiently alarming in themselves; steel ducting has been torn open, heavily constructed classifiers have been wrecked, and men have been injured. The Central Electricity Authority, the most experienced and important user of such plant, has been considering, in association with the Factory Department, measures to reduce the incidence of these explosions. The precautions contemplated comprise the provision of isolating devices and suitable explosion reliefs, and a code of practice has been drawn up to meet the different eventualities which may arise in the working of the plant. Experimental work will be carried out at the Mines Research Station at Buxton by the organization jointly controlled by the Department of Scientific and Industrial Research, the Ministry of Fuel and Power and the Factory Department. It is expected that information will be obtained from this work to enable conclusions to be drawn concerning suitable explosion reliefs for the plant in question and to enable decisions to be made relating to strength in the design of the plant. The conclusions are certain to be of interest to all users of such plant.

The combination of disintegrator and cyclone continues to be one of the commonest causes of explosion in the grinding industry. There is an obvious reason for this. The friction and percussion of a high-speed hammer-mill or disintegrator provide a very likely source of ignition, particularly if a hard foreign body such as tramp iron or a pebble enters the mill. Glowing material may then pass to the cyclone, in which a dust-cloud is likely to be present in an explosive condition. For this reason, Inspectors are constantly encouraging managements to arrange that cyclones which settle inflammable powders and dusts are situated in safe positions. The safest situation for a cyclone, or a bag-filter, is outside the building altogether, either on the roof or in the factory yard. Sometimes the conditions of the process are such that cyclones and bag-filters must be inside the building. Even then, the spread and effects of an explosion can be reduced by isolating these items from the occupied rooms of the factory. This can be done by situating the settling plant near an outside wall of the building and surrounding it by a strong enclosure with an explosion relief vented to the open air. When the cyclone discharges the settled material back into a receiver or into plant in an occupied room, it is important that flame and blast from the explosion should be prevented from entering the room through this discharge point. This is usually done by fitting to the cyclone discharge a choke, in the form either of a rotary valve or of a short screw-conveyor, so arranged that a

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plug of material is always present to impede the free passage of flame and blast from the cyclone at its delivery. An explosion relief should be provided on the cyclone to reduce to a minimum the pressure of the explosion. The need for such an arrangement became apparent when an explosion occurred in a mill-and-cyclone installation which was grinding scrap linoleum. The sequence of events was similar to that described above. Ignition originated in the mill and spread to the cyclone, where an explosion occurred. The flame of the explosion passed through the free outlet at the bottom of the cyclone, igniting material on screens underneath, and a serious fire developed in the screen room. The provision of a rotary valve on the cyclone delivery and of an explosion relief on the cyclone body would probably have prevented this secondary fire.

Fires caused by Inflammable Dusts

Although an explosion is the most impressive consequence of the presence of an inflammable dust in a building, there is no doubt that the commonest consequence is the occurrence of fire of a non-explosive character. The great majority of fires reported from this cause are not accompanied by injury to the workpeople. Nevertheless, the dangers associated with a fire risk should never be underestimated, and precautions which serve to reduce this risk should never be neglected. When the risk arises from the presence of inflammable dust, the most important single precaution is, of course, cleanliness. The importance of the above considerations was underlined by the occurrence of a serious burning accident in a cotton waste factory. This industry is accustomed to fires, and considerable dexterity has been developed by the workers in dealing with them. The causes of the fires are well known and the necessity of preventing accumulations of dust is appreciated. Inflammable dust is produced so rapidly in the processes, however, that any slight slackening in cleaning-up rapidly produces an accumulation. In the case in question, although an efficient vacuum cleaner was provided, cleaning had been omitted because of the occurrence of a holiday. Fire occurred at a breaking machine and the three women at the bagging end immediately rolled the receiving bag out of the room and closed the fire door. This by no means abnormal occurrence was on this occasion turned to catastrophe because the fire spread rapidly along accumulations of dust on the beams and overtook the women as they made their escape. Their clothing caught fire and all three were burned, two of them fatally. A fourth woman who went to their assistance was also badly burned.

Celluloid Fires

The traditional trades to which the Celluloid Regulations, 1921, originally mainly applied are now to a substantial extent using less inflammable materials in place of nitrate-based celluloid. The development of non-flam film, referred to in recent Reports, has very considerably reduced the application of the Regulations to the film developing and printing industry. The storage of old film and the handling of imported film used by amateur photographers, however, still produce a risk.

The freedom from fires involving celluloid film, which obtained during 1954, has not continued. In 1955, two incidents were reported; in one case processed film in store was involved and in the other, film which was being stripped. Fortunately, no personal injuries resulted from either incident.

The processed film in store was library material containing a proportion of old film. Fumes were noticed escaping from a storeroom and shortly after-

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wards the sprinkler alarm-bell sounded. Within a short time there was a violent explosion, involving four storerooms, which shattered the glazing of the gas-relief spaces and burst open the hardwood doors. The fire brigade had been summoned when the sprinkler alarm sounded, but although they arrived very promptly the fire was already almost extinguished by the water sprinkler system. The cause of the fire could not be determined with certainty, but it is thought that a tin containing a reel of old nitrate film might have been resting on a hot-water heating pipe. The temperature of the heating system in the storeroom was normally about 105°F. but, on the day in question, more heat had been required in the canteen and this could have boosted the temperature of the pipes in the storerooms to approximately 120°F. This temperature, over a short period, would not be likely to affect relatively new film, but could easily have caused rapid decomposition and spontaneous ignition of old and unstable material.

The cause of the fire which occurred when film was being stripped could only be ascribed to spontaneous ignition. The fire was very fierce and caused considerable damage to the structure and to the plant.

The film received by film strippers varies widely in age but since no nitrate film has been sold by the manufacturers since September, 1951, it is probable that practically all the material sold prior to this which was used for the production of projection copies of feature-films, will by now have reached the strippers, having outlived its useful life. Consequently, present supplies of nitrate film to strippers consist almost entirely of film which has been kept in film libraries for reference or record purposes and which is being discarded, or "junked", as it becomes outdated or is replaced. Such material may well be 20 to 30 years old. Nitrate film of this age is likely to be unstable and the stripping process increases the tendency to instability. Any nitrate film which is still held as library material or which is being stored or stripped should be treated with extreme care and should be kept away from any sources of heat which could raise its temperature above normal atmospheric temperature. Periodic examination, at intervals not exceeding six months, of all nitrate film more than 20 years old, is desirable in order to detect incipient deterioration of the nitrate base.

Deterioration may be indicated by any one of a number of features, viz., yellow discolouration, fading of the image, undue brittleness of the material or stickiness of the emulsion coating. Film showing any of these characteristics should be removed from the store and destroyed. By this means, the potential "fuse" action on the other contents of the storeroom exercised by individual films which are approaching dangerously close to a state where spontaneous ignition is possible can be minimized. Film for stripping is normally sorted and re-reeled before processing. During this preliminary operation it should be carefully examined so that material showing any abnormality may be set aside and burned to avoid the risk of its becoming ignited during, or immediately after, the stripping process.

In view of the near-explosive qualities of unstable or deteriorated nitrate film, destruction by burning should only be done by a responsible person out-of-doors, on an open space remote from goods or property which might be affected by the burning film.

Sheet celluloid has been in use for many years as the raw material for a variety of articles, including the handles of table knives, spectacle frames (mainly for export), fancy goods and bicycle accessories such as pumps and mudguards. Its hazardous nature is generally realized in premises where it is being processed and the necessary precautions are usually taken. This was

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not so in one case, however, where, in a factory engaged in the manufacture of spectacle frames, sheets of celluloid had to be softened by heating so that they could be cut into strips by rotary knives. The heating was done on the shelves of an oven with an open front, the heating medium being a 1-kilowatt electric hot-plate standing on the bottom of the oven and separated from the shelves by a metal plate. No thermometer was provided to indicate the oven temperature and the only control was the manual switch for the hot-plate. A worker put a sheet of celluloid in the oven and apparently forgot it. After a time, the sheet ignited, the flames spread to other celluloid in the room (about 70 lb.) and the resulting conflagration gutted the whole building, fortunately without causing any personal injury. There is no doubt that this incident was caused by the decomposition of the celluloid by excessive heat within the oven, ignition being either spontaneous or due to the gases of decomposition being ignited by the hot-plate. It was later found that the material could be softened sufficiently by immersion, for a short period, in hot water at a temperature somewhat below boiling point.

Although it has long been known that celluloid film approaching ten years old and upwards is liable to decompose and to ignite spontaneously, there has till now been no clear evidence that similar risks existed with sheet celluloid, which, due to the higher content of plasticizer and, often, to the inclusion of a large proportion of inert filler, is a more stable material. Moreover, stocks of sheet celluloid or manufactured articles are not likely to be stored for a period long enough for deterioration to make itself evident. The circumstances of a fire and explosion which occurred during the year indicated, however, that old sheet celluloid can be extremely dangerous. The incident occurred in a storeroom containing stocks of tubes intended for the manufacture of bicycle pump bodies, and included material which was between 25 and 30 years old. Fortunately, the storeroom was equipped with a water-sprinkler system which operated and extinguished the fire before the whole of the stock was involved, but the initial explosion caused considerable damage to the structure of the storeroom. The burst of flame which accompanied the explosion swept down the passage between the storeroom and the adjoining factory block and set the tarred roof of the factory alight. There was no evidence to support any conclusion as to the origin of the fire other than that of spontaneous ignition of the old stock.

In factories where celluloid articles are manufactured, even if the full extent of the risk is not always realized, the dangers of the material are known to some extent and such fires as do occur are usually due to failure to comply with the appropriate Regulations, in consequence of some negligence or carelessness. The degree of risk is greatly increased when the material, in not readily recognizable form, is used in processes in which the product is not even remotely connected with celluloid. This was tragically demonstrated by a fire in which three women lost their lives. This fire originated in the spontaneous ignition of thick plates of celluloid, used as assembly boards and cutting plates in a factory in which handbags were made. A number of the plates had been kept, for about two years, in a pile on a shelf in a workroom on an upper floor. The plates were dense black in appearance and were known to the workers only as " blackboards ". A pendant electric light had been moved from its normal position and tethered to the framework of the shelves, so that the lamp was only a few inches above the surface of the top plate of the pile. One of the workers saw smoke coming from the pile and threw water over it. As he was throwing on more water, the mass glowed, burst into flame and an explosion followed. The fire spread with great speed, blocking the stairway down which the three women who perished had sought to make their escape. There is no doubt that the

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fire was caused by the decomposition and spontaneous ignition of the "blackboards". Decomposition had been started by the relatively low temperature generated by the pendant light and had continued over a long period until it finally became violent. The decomposition of celluloid is an exothermic process and once started it continues, in the absence of adequate cooling, at an ever-increasing rate, until a sufficient temperature is reached for ignition to take place.

Apart from the risk of fire due to spontaneous ignition, the use of celluloid in such an unfamiliar form on premises where there may be no other serious fire hazard introduces very dangerous possibilities. Celluloid of this type is quite widely used as cutting sticks on guillotines and as cutting plates on various types of punching presses in a variety of industries, as well as for assembly boards. Although each stick or plate has an identifying label when new, the label may be either detached to obtain a perfectly smooth surface, or it may cease to serve as a means of identification if, as is often the case, the plates are cut into smaller sizes. Cutting sticks and plates of a non-flam substitute are available from the same suppliers and firms should use these in preference to those made of celluloid. Although the cost of the non-flam substitute is greater than that of celluloid, the extra expense is an insignificant amount in the total costs of the consumable stocks for any factory. If, for any reason, celluloid cutting sticks or plates must be used, suitable arrangements should be made for their safe keeping whenever they are not in actual use. If the quantity is small, not exceeding 1 cwt. in amount, this may take the form of a closed metal container, outside the workroom and away from any possible source of heat, but large quantities should only be kept in a properly constructed storeroom provided with adequate ventilation. In no case should the position of the storage container or storeroom be such that any means of escape from the factory would be endangered if the celluloid became ignited.

In general, very little difficulty has been experienced in persuading users to change over to less inflammable materials, and much progress has been made. This does not apply, however, in all industries where celluloid is used. For many manufactured articles no satisfactory substitute has yet been found. Where transparency is important, as in certain types of instruments, celluloid is still used. Its use as covers for engineering drawings, showcards, etc., appears to be increasing. Its moulding properties are still deemed essential for the covering of wooden heels, and celluloid is still considered in the trade to be the best material for table-tennis balls.

Experience has shown that the hazards of celluloid are so great that the greatest attention must be paid to safety in the conditions under which it is used and stored, and that it should where possible be replaced by some less inflammable material.

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CHAPTER 9

Pressure Vessel Explosions

Steam Boilers and other Steam Apparatus

TABLE 19 shows the number and causes of explosives involving steam plant which have occurred during the past five years, the total number of cases during each year from 1951 to 1955 inclusive being 68, 81, 83, 53 and 84 respectively.

TABLE 19

EXPLOSIONS FROM APPARATUS CONTAINING STEAM UNDER PRESSURE DURING THE PERIOD 1951 TO 1955 INCLUSIVE

	Cause of Explosion	Water Tube Boilers	Horizontal Shell Boilers	Vertical Boilers	Loco Boilers	Hot Water Heating Boilers	Stop Valves	Piping	Steam Tube Ovens	Steam Receivers	Steam Traps	Steam Containers	Other Steam Apparatus	Total
Defective Fittings	Stop Valves	6	4	3	1	—	—	—	—	5	—	—	2	21
	Connections ..	3	4	13[3]	—	—	1	19[2]	—	3	1	—	2	46[5]
	Failure of Automatic Appliances ..	—	4	—	—	1	—	—	14	—	—	—	—	19
Overpressure	Failure of Pressure Relief or Control Valves	—	—	—	1	—	—	—	—	3	2[1]	—	1	7[1]
	No Automatic Relief Provided	—	—	—	—	—	—	—	—	6	—	—	1	7
	Failure of Shell ..	5[1]	4	—	1	—	—	—	—	5	—	—	2[1]	17[2]
	Failure of Tubes ..	15[1]	2	—	1	—	—	5	16[1]	6	—	—	—	45[2]
	Failure of Furnace ..	—	1	1	—	—	—	—	—	—	—	—	—	2
	Freezing-up	—	—	—	—	—	3	—	—	—	5	2[1]	—	10[1]
	Defective Construction	2	6[1]	2	—	—	—	6	3[1]	7	—	1	4[1]	31[3]
Overheating	Failure of Smoke or Water Tubes due to Water Shortage ..	20	5[1]	—	2	—	—	—	—	—	—	—	—	27[2]
	Failure of Shell due to Water Shortage ..	1	6	—	—	—	—	—	—	—	—	—	2	9
	Excess Exposure of Tubes	—	—	—	—	—	—	—	51	—	—	—	—	51
	Burst Water Gauges ..	12	8	2	2	—	—	—	—	—	—	—	—	24
	Water Hammer	2	7[1]	—	—	—	2	7[2]	—	1	—	—	—	19[3]
	Furnace Blow-outs ..	—	5	1	—	—	—	—	—	—	—	—	1	7
	Removal of Fittings or Covers under Pressure	3[1]	4[2]	3	—	—	—	—	3	13	1	—	—	27[3]
	TOTAL	69[8]	60[5]	25[3]	8	4	3	37[4]	87[2]	49	9[1]	3[1]	15[2]	3<0[21]

Fatal accidents indicated by raised figures (included in lower figures).

Of the accidents which occurred during 1955, 14 occurred as a result of covers or fittings being removed from vessels or pipes under pressure. This figure is significantly higher than the average for the past five years. Three of

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these accidents happened on shell boilers. The circumstances were all very similar and the occurrences can well be illustrated by one which was caused by the removal of a manhole cover from a Lancashire boiler. A slight leakage having been noticed, the fires were drawn and the boiler was blown down in order to effect the repairs. This preliminary work had been done within the space of two hours and the engineer, having become impatient at the time taken for the boiler and flues to cool down, commenced to remove the nuts securing the manhole cover. The cover blew off and he was badly scalded by the steam issuing from the opening. The whole course of the operations in this case was wrong and the inevitable accident occurred. There is no quick method of cooling down a boiler; the vessel and the surrounding brickwork should be allowed to cool before the water is run off, and before any attempt is made to remove manhole or inspection doors great care should be taken, even when the boiler is apparently cool, to see that there is no steam, even at apparently negligible pressure, still within the boiler; care should also be taken to ensure that the vessel is not under negative pressure.

Six of the 14 persons injured during 1955 as a result of removing fittings or covers were working at steam receivers. One man was severely scalded when he removed the lid of a rag boiler while the vessel was still under pressure. Normally, pressure was released by opening a blow-down valve at the bottom of the vessel. The operator opened the valve and, for a short time, steam and water issued from the pipe. When the emission ceased, it was concluded that the vessel was empty and he proceeded to release the bolts securing the lid. Before the last nut was removed the lid blew off with considerable violence. Investigation showed that a grid covering the outlet to the blow-down valve had become choked with pieces of paper. It is possible to provide an interlock for lids of this description by fitting on the shell a release valve so arranged that until the valve is opened to allow any steam pressure to disperse, the lid cannot be released. Where lids are secured by swing-over bolts, it has been found advantageous to provide a strong flange on the cover lugs through which the bolts pass. This ensures that the cover can be raised a short distance from its seating on the vessel by unscrewing the nuts slightly and until this has been done it is not possible to throw over the bolts. Any steam under pressure can therefore escape while the cover is still held captive by the bolts.

Two men were badly scalded, one fatally, when working inside the mud-drum of a water-tube boiler. The blow-down was common to a range of water-tube boilers and, since more than one key was available for operating the blow-down valves, one of the other boilers in the range was blown down while the valve on the connection to the drum in which the men were at work was open. It is surprising that this type of accident can still occur; the danger arising from having more than one key to open the valves on a common blow-down system should by now be well known. It should not be possible for the key to be removed from any such valve unless the valve is closed.

Erosion of generating tubes on water-tube boilers due to the action of soot-blowers was responsible for two explosions. Corrosion of both generator and superheater tubes resulted in explosions from three water-tube boilers and two economic boilers. Soot-blowers, if wrongly adjusted or manipulated, can cause rapid erosion of the tubes in the direct path of the jet, especially if hard abrasive particles are conveyed by the hot furnace gases, which occurs with certain types of fuel.

Defective fittings and connections caused scalding in 17 cases during the year under review. The majority of the failures occurred in consequence of

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insecure joints, which gave way when subjected to pressure for the first time. Flexible pipe joints are a common cause of failure; experience shows that great care is necessary when tightening up such joints if damage, not readily obvious, to the pipe-end is to be prevented.

Twelve explosions from bakers' steam tube ovens occurred during 1955, but only one of these caused personal injury. Overheating due to careless firing was responsible for one occurrence, and in two other cases the overheating was caused by maladjustment of the gas flame burners, whereby the flame impinged directly on to the tube ends. Three of these explosions in ovens were caused by excessive exposure of tube ends, two being due to wastage of the furnace brickwork, while in the other case the inner furnace wall had been rebuilt in such a way that too great a length of the tubes was exposed within the furnace. Over-exposure of tubes has for many years been a prolific cause of explosions; experience shows that wasted brickwork should receive early attention whenever examination shows wastage to have occurred. When furnace walls are being rebuilt, the oven maker should be consulted in order to ensure that an excessive length of tube is not exposed.

Another type of accident has occurred in connection with steam tube ovens which, although it is not a steam explosion and is not, therefore, included in Table 19, is mentioned here as a matter of interest. Conditions inside the tubes, in terms of temperature and pressure, are very arduous, and gas forms, either by dissociation of water into electrolytic gas, or by reduction of steam to hydrogen by the metal of the tube. In either case, an inflammable gas is formed. When too much gas has accumulated, the tube becomes a poor conductor of heat, and must be "degassed", i.e., the tube must be opened to allow the gas to escape. Two men were drilling a hole in a steam tube for this purpose with a portable electric drill and, as soon as they had penetrated the wall of the tube, the gas rushed out and ignited at the drill. The man who was using the drill suffered bad burns on both hands. The other one drilled another tube, keeping well back from it; the gas again ignited and flames reached the ceiling. When a hand drill was substituted for the electric drill, the work proceeded without further trouble. With any portable tool, however, there is a tendency on the part of the workman to have his face immediately over the hole that he is drilling, and even with non-electrical tools (i.e., with no obvious means of ignition) there must be a risk of being blinded; thus it would seem better to have the tubes drilled by a bench drill, rather than by a hand drill.

Water hammer caused three explosions during the year, one of which was very serious. This occurred in a large factory where production was held up for several days, serious scalding injuries being sustained by one of the boiler-house attendants. In another case, the large common main connecting a number of water-tube boilers burst with considerable violence when water which had collected within the main was disturbed by the opening of a turbine control valve. Other explosions resulting from water hammer could have been avoided had the layout of the piping system been sound and had due regard been paid by the attendant to simple precautionary measures. Steam piping should be arranged with a continuous fall, in the direction of steam flow, from the boiler junction valves towards a water separator, or drop-leg, at the end of the range. Separators are also required at other low points in the system where, for example, the piping rises to clear obstacles; at the highest point in each section of a range drained by a separator or drop-leg, an automatic air valve should be fitted to prevent vacuum formation. In addition, each separator or drop-leg should itself be drained by means of a trap and also by a direct by-pass to atmosphere. Operators should also bear in mind that

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before steam is admitted to a range of piping any water should be drained away and that even then the steam should be admitted slowly.

Shortage of water was responsible for overheating and subsequent explosions in three horizontal shell boilers and in one water-tube boiler. Recent reports by the Ministry of Transport on boiler explosions due to water shortage have stressed the dangers of leaving boilers unattended for lengthy periods and of relying entirely on automatic devices. Without attempting to discourage the use of automatic instruments, such provision must not be assumed to obviate frequent inspection of the water gauges in order to ensure that a proper water level is maintained.

Vessels containing compressed air or other gases

Table 20 shows the number and causes of explosions caused during the period 1952 to 1955 inclusive by apparatus containing air and other gases under pressure. Of these, 180, including 6 fatalities, occurred during 1955, the numbers during the preceding three years being 126, 169 and 146 respectively.

TABLE 20

EXPLOSIONS FROM APPARATUS CONTAINING AIR OR OTHER GASES UNDER PRESSURE DURING THE PERIOD 1952 TO 1955 INCLUSIVE

Cause of Explosion	Glass Bottles	Pneumatically Tyred Wheels	Piping and Connections	Miscellaneous Vessels and Containers	Valves, Gauges and Other Fittings	Cylinders of Pumps and other Machines	Compressors and Blowers	Hydraulic Accumulators	Air Receivers	Tanks	Drying Cylinders	Gas Cylinders	Air/Oil or Grease Containers	Total
Test of Vessels ..	—	—	17[3]	7[1]	9	5	1[1]	—	16[3]	1	2	8	—	66[8]
Defective Joints, Fittings and Valves ..	—	—	18	5	2	16	8	·5	14	—	—	19	2	89
Oil Vapour Explosions	—	—	1	—	1	—	1	—	2	—	—	1	—	6
Unsound Construction	—	—	1	—	—	4	5[1]	—	3[1]	1	—	8[3]	—	22[4]
Overpressure ..	31	8	20[1]	6	4	—	1	—	6	1	—	10[1]	1	88[2]
Displacement of Fittings	—	—	4	26	—	—	8[1]	—	8	—	—	5	—	51[1]
Handling	155[1]	—	1	—	—	—	—	—	—	—	—	1	—	157[1]
Displacement of Rim or Flange ..	—	106[4]	—	—	—	—	—	—	—	—	—	—	—	105[4]
Burst Tyres	—	22	—	—	—	—	—	—	—	—	—	—	—	22
Breakage of Wheel ..	—	9[1]	—	—	—	—	—	—	—	—	—	—	—	9[1]
TOTAL ..	186[1]	145[5]	62[3]	44[1]	16	25	24[1]	5	49[3]	3	2	52[1]	3	616[19]

Fatal cases indicated by raised figures (included in lower figures).

The number of accidents involving pneumatic tyres occurring during 1955 was 44, which was higher than the average for the three preceding years. Despite the publicity given to the need for guards, both when inflating tyres with detachable rims and when removing divided wheels from a vehicle, there is still too much apathy about the use of guards, even where these are provided. Many of these accidents occurred in large undertakings where the need for taking precautions must have been known. At one such garage, a man lost the sight of both eyes and suffered other facial injuries when struck by the flying rim of a tyred wheel undergoing inflation. A suitable type of cage designed to prevent injuries in such a case is illustrated on Form 428, a

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placard published by H.M. Stationery Office and suitable for display in premises where these tyres and wheels are used. In the case of two of the accidents, this placard was exhibited on the premises, but no attempt had been made to provide the guards recommended. In one of these cases, the man involved in the flying-rim accident suffered a fractured skull; in the other, which happened in a large garage, the injured person sustained a broken jaw. Sometimes accidents of this kind occur while a tyre is being inflated on the vehicle. After one such accident a portable guard was constructed which could be placed in front of the wheel on which the tyre is being inflated, to prevent the mechanic being struck if a portion of the rim should fly out. In seven other cases, injuries were caused when wheels disintegrated, one accident ending fatally. Six of the wheels were of cast iron and were in use on barrows or trucks. These explosions were undoubtedly due to excessive tyre-pressure, the result of using high-pressure compressed-air lines not intended for tyre inflation. The use of cast iron for wheels of which the rims virtually serve the same purpose as the walls of a pressure vessel is unsatisfactory; a tougher and less brittle metal should be employed.

There was also a slight increase in the number of accidents due to glass bottles bursting under pressure. The fact that the machines on which the bottles are filled are generally so constructed as to retain the broken fragments should a bottle burst when first subjected to pressure, reduces the potential risk from glass bottles. The accidents usually occurred when the bottles were being handled, and although most of the injuries were slight, the effect could have been minimized had persons exposed to the risk been wearing adequate protective clothing.

Forty persons were injured during 1955 as a result of defective joints and fittings. As in the case of similar accidents with steam piping, insecure joints were generally the cause. To obviate these defects, the jointer has a considerable responsibility in ensuring that the joint is properly made, and this requires not only the exercise of care, but full knowledge of the essential features of the particular type of connection.

The use of compressed air or other gases for the purpose of carrying out pressure tests on vessels is a dangerous proceeding. The number of accidents due to this cause was greater than the average for the preceding three years, and there were 3 fatalities. Where a gas pressure-test is essential, it should be preceded by a hydraulic test in excess of the gas test pressure. Sometimes, however, the reason for carrying out test under air pressure in preference to a hydraulic test is no more than a matter of convenience. At one factory, an air test was being made on a casting for a valve casing. The man carrying out the test was severely injured when an end-plate blew off. Formerly the castings had been subjected to hydraulic test, and the only reason for the change was, apparently, that hydraulic testing costs more.

On a public works contract, a cast iron water pipe was subjected to an air test while men were at work in the trench. A ganger, inspecting the line, noticed bubbles coming from water surrounding a joint. Investigation revealed a crack in the pipe and, while examination was still in progress, the pipe burst, killing a nearby workman. Although a gaseous test was necessary in order to ascertain that there was no leakage from joints, it appeared probable that if each length of pipe had had a proof test under hydraulic pressure at the makers' works, the defect would have come to light.

In two of the cases where vessels failed under air test, the apparatus was such that for technical reasons a hydraulic test was undesirable. Cases of this kind are rare, but when for any reason it is impracticable to carry out a prior

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hydraulic test, any gaseous test should be carried out with all personnel adequately protected by blast walls; observations of the test should then be made by remote methods. An example of the effectiveness of blast-proof arrangements can be quoted. In a factory which had once been concerned in an accident involving air pressure-testing, a blast-proof cell was constructed for the vessels under test, the adjacent room being separated by a thick brick wall. A vessel undergoing test exploded at a pressure of approximately 2,000 lb. per sq. in. Two men behind the protective wall were uninjured, but the fact that they were slightly affected by the noise and the pressure waves gives some indication of their probable fate had they been exposed to the full force of the explosion.

CHAPTER 10

Accidents at Building Operations and Works of Engineering Construction

Building Operations

THE upward trend in the total number of accidents reported from building operations continued, the increase over the previous year amounting to 5 per cent. There is a small but not significant increase this year in the number of fatal accidents. Table 21 shows the numbers of accidents reported over the period 1950-1955.

TABLE 21

ACCIDENTS AND FATAL ACCIDENTS AT BUILDING OPERATIONS, 1950-1955

Year	Total Accidents Reported	Number of Fatal Accidents
1950	13,302	191
1951	12,340	213
1952	12,702	207
1953	13,766	187
1954	13,903	172
1955	14,561	184

The increase in the total number of accidents reported was by no means general over the whole country; the figures for London and the Home Counties differed little from those in the previous year, whereas in other areas, particularly in the East and North, the increases were substantial, amounting in two Divisions to 18 and 16 per cent respectively. Inspectors generally are of the opinion that many notifiable accidents are still not reported, especially

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by the smaller builders, some of whom seem to be unaware of their statutory obligation to report accidents to the Factory Department. Proceedings have been taken in several cases of failure to report an accident.

After making due allowance for the fact that the standard of reporting is improving year by year, thus increasing the known as against the actual number of accidents, there is no doubt that the building industry as a whole is not facing up to its responsibilities in the matter of accident prevention. Although among many of the larger building firms there has been a marked improvement in the standard of compliance with the Regulations, this improvement is by no means universal, while the attention given to safety by most of the smaller firms, especially by those engaged on maintenance and jobbing work, remains almost negligible. The standard of compliance by the various trades varies considerably, painters and decorators being among those who have little regard for safety in their methods of working. Their scaffolds frequently comprise a single plank, either supported by two ladders or trestles an excessive distance apart, or laid across roof truss members or across the transoms of a putlog or independent scaffold ; the footholds of these men are thus particularly precarious when they move the plank around as the work progresses. Although this trade is specifically mentioned, it is by no means the only one in which little regard is paid to safety. In almost every trade, not only small firms, but many of substantial size give only lip-service to safety. Many of these firms operate all over the country and their methods of working set a bad example to local firms engaged on the same projects.

The attitude of the workmen is often disappointing, even in the more progressive firms, which are making a real effort to improve conditions. There is appreciable apathy among building operatives towards the Regulations, and they are often persistent in their opposition to safeguards which they think may interfere with their method of working or may endanger their bonus earnings. On the whole, trade union officials are keen to see the Regulations enforced. Unfortunately, however, their attitude is not shared by many of their members.

Many accidents occur because men make-do with whatever gear comes most readily to hand instead of taking trouble to carry out instructions and use sound gear. A man sent to repair the roof of an outbuilding at a dwelling house brought with him perfectly sound ladders. However, in the garden he found an old trestle which he thought would support him. He stood upon it and the central wooden member broke, with the result that he injured his right leg. The unsuitability of the trestle, which, according to the occupier of the house, had been lying there for many years, was easily seen. Other accidents were due to the foolhardy and unco-operative attitude of the employee concerned. In another way also, the workers are not co-operating: more than one Inspector, in attempting to obtain information necessary in order to consider whether legal proceedings should be taken against building employers, has been refused that information, which only the workers were able to give. The workers, under Section 123 of the Factories Act, 1937, are legally obliged to give such information, provided that it does not tend to criminate them, and it is much to be hoped that the obstructive attitude now sometimes met with will not continue.

The accidents reported have been analysed according to causation and this analysis is shown in Table 22, the figure shown for each causation being expressed as a percentage of the total number of accidents for all causations. The figures for 1954 are also given for purposes of comparison.

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TABLE 22

BUILDING OPERATIONS: ANALYSIS OF ACCIDENTS BY CAUSATION, 1954 and 1955

Cause of Accident	Percentage of all Building Accidents							
	Falls of Persons from				Falls of Materials from			
	6′ 6″ or less		Over 6′ 6″		6′ 6″ or less		Over 6′ 6″	
	1954	1955	1954	1955	1954	1955	1954	1955
1. FALLS OF PERSONS OR MATERIALS								
(a) From scaffolds during erection, alteration or dismantling	0·59	0·61	0·86	1·04	0·47	0·61	0·35	0·40
(b) From working platforms of:—					0·09	0·08	0·03	0·05
(i) trestle or ladder scaffolds	1·22	1·43	0·84	1·05	—	0·01	—	0·01
(ii) cradles (Reg. 17)	0·01	0·03	0·09	0·06	0·18	0·18	0·44	0·44
(iii) other scaffolds or from gangways or runs	2·09	2·03	2·74	2·55	0·05	0·11	0·07	0·09
(c) From ladders or step ladders	3·03	3·20	3·54	3·38	—	—	—	0·01
(d) From boatswain's chairs, skips, etc., (Reg. 18)	0·01	—	0·05	0·05	0·01	0·04	0·08	0·10
(e) Through openings in floors or walls or from stairways	1·02	1·08	0·84	0·89	—	0·01	—	0·01
(f) Through roofing material	0·13	0·18	1·25	1·26	0·03	0·06	0·03	0·09
(g) During work on sloping roofs (except (f) above)	0·63	0·46	1·12	1·02	0·32	0·32	0·30	0·21
(h) From building structure during demolition	0·15	0·14	0·41	0·59	0·15	0·31	0·08	0·05
(i) Into excavations (Reg. 77)	1·13	1·05	0·12	0·18	0·81	0·72	0·16	0·40
(j) From working places other than above	1·80	1·42	1·31	1·34	2·53	2·68	1·06	1·04
(k) Other, from heights (except hoists)	1·06	0·75	0·77	0·62				
(l) On the flat:—					0·09	0·24	—	0·08
(i) due to obstructions, overlapping boards etc.	1·87	2·03	—	—	1·57	1·61	—	—
(ii) Other	5·06	5·03	—	—				
TOTALS	19·80	19·44	13·90	14·03	6·30	6·98	2·80	2·98

Cause of Accident	Percentage of all Building Accidents	
	1954	1955
1. FALLS (Totals brought forward)	42·80	41·43
2. EXCAVATIONS AND EARTHWORKS—Collapse or fall of earth or material	0·43	0·35
3. LIFTING APPLIANCES (EXCEPT HOISTS) AND LIFTING GEAR (Regs. 34 to 65, 73, 74)		
(a) Cranes (i) collapse due to overturning, failure of anchorage	0·09	0·12
(ii) collapse of any part (other than (i) above)	0·09	0·08
(iii) other causes	0·77	0·85
(b) Excavators and draglines	0·15	0·15
(c) Lifting appliances other than above	0·63	0·54
(d) Lifting gear	0·32	0·32
4. HOISTS (Regs. 66 to 72, 74)		
(a) Fall of platform or cage	0·15	0·18
(b) Fall of persons down hoistway or from platform or cage	0·12	0·15
(c) Falls of materials down hoistway or from platform or cage	0·12	0·16
(d) Trapping by hoist	0·20	0·15
(e) Other	0·26	0·27
5. MACHINERY (Regs. 85, 86)		
(a) Power operated machinery	3·28	3·55
(b) Other machinery	0·39	0·35
6. USE OF EXPLOSIVES	0·07	0·09
7. STEPPING ON OR STRIKING AGAINST OBJECTS (EXCEPT FALLS)		
(a) Protruding nails	4·28	3·90
(b) Other	5·33	4·80
8. CARRYING, WHEELING, MOVING OR LIFTING BY HAND (NOT INVOLVING FALLS)		
(a) Cuts, bruises and abrasions	9·27	8·32
(b) Strains, ruptures and fractures	9·92	9·60
(c) Other	1·79	1·80
9. USE OF HAND TOOLS (NOT POWER DRIVEN)	8·98	8·95
10. MECHANICALLY PROPELLED VEHICLES		
(a) Tractors, dumpers, scrapers, bull-dozers, etc.	1·16	1·55
(b) Road vehicles (other than (a) above)	2·49	2·84
(c) Other	0·27	0·50
11. MISCELLANEOUS	6·66	7·00
TOTAL OF ALL ACCIDENTS	100·00	100·00

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As usual, falls of persons and materials accounted for over 40 per cent of the accidents, the percentages for falls of persons and materials respectively differing little from those for the previous year. The percentages due to the other causations also differed little from those for 1954, with three exceptions. The causations of stepping on or striking against objects and of carrying, wheeling, moving or lifting by hand each showed a reduction of about 1 per cent, while the number of accidents arising from mechanically propelled vehicles increased by approximately 11 per cent. The changes in these three causations no doubt reflect the greater mechanization of the industry, the greater use of mechanically-propelled vehicles obviating some of the risks due to striking against objects and carrying, wheeling or moving by hand. The overall decrease from these three causations represents more than 150 accidents.

Of the fatal accidents, falls of persons accounted for 71 per cent, falls of materials for 7·4 per cent, mechanically propelled vehicles for 6·2 per cent, and lifting appliances and lifting gear for 4 per cent. Less than 2 per cent of the falls of persons which terminated fatally occurred from heights of 6 ft. 6 in. or less. The ratio of fatal to non-fatal accidents was as follows: in the case of falls of persons from heights over 6 ft. 6in., 1:16; in the case of collapses of excavations, 1:17; in the case of hoists, 1:32; in the case of falls of materials from heights over 6 ft. 6 in., 1:37; in the case of lifting appliances and lifting gear, 1:42; and in the case of mechanically propelled vehicles, 1:64.

Falls of Persons

With the exception of falls from working platforms, falls from ladders and stepladders provided the most common cause of accident, accounting for 26 per cent of the falls of persons from heights. Approximately half of these falls occurred from heights of less than 6 ft. 6 in., but 14 of the 15 fatalities occurred from heights in excess of 6 ft. 6 in. Falls from working platforms accounted for 27 per cent of all falls and, again, half of these were from heights of less than 6 ft. 6 in. In this category, 23 of the 24 fatalities resulted from falls above 6 ft. 6 in. One-third of these cases of falls from working platforms involved trestle and ladder scaffolds and approximately two-thirds of the accidents occurred from framed scaffolds, gangways and runs. Cradles were involved in only 14 cases, representing less than one-third per cent of the number of falls of persons from working platforms. Falls of persons from sloping roofs showed a welcome reduction of 11 per cent on the figure for 1954, as against an overall increase of 11 per cent in all categories. There was an increase of 13 per cent in accidents due to falls through roofing material.

The special investigation carried out in the latter half of 1954 into the causes of accidents due to falls of persons and materials occurring in the South, North and Midlands was completed during the year. This showed that, in so far as it is practicable to make positive provision to prevent accidents, the existing requirements of the Regulations are adequate for the purpose, although it was clear that 40 per cent of the accidents which came under scrutiny during the investigation would either have been prevented, or their consequences minimized, had there been proper observance of the Regulations. Industrial building appeared to produce more accidents than house building, maintenance of existing factory buildings being particularly hazardous. Simple operations, such as replacing a glass pane in a window or putting a new asbestos-cement sheet on a roof, were shown to produce a number of accidents out of all proportion to the number of man-hours spent on the job.

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The painting trade is the most hazardous for falls, both in frequency and severity, and this is largely due to the insecurity of the equipment customarily used, e.g., ladders, trestle scaffolds and unfenced planking. On sites where there is no one specially appointed to ensure the safe conduct of the work, the incidence of accidents is high; this is also the case where the person appointed is the general foreman or some other person who is already fully occupied with other duties apart from those which he must necessarily carry out if his efforts to achieve a safe system of working are to be effective.

Steel erection is one of the trades in which little progress has been made in the development of methods of working. The problem is an old one and the number of accidents which occur to steel erectors is a reminder that some solution must be found. One firm has been trying out a system whereby the bolters-up are hoisted by the crane on special saddles attached to the steel member to be fitted in position. After the member has been located and bolted up, the men are lowered again to the ground on the saddles, which, after the fixing, have been detached from the steel member. The adoption of safer methods of working depends, however, to a great extent on the attitude of the steel erectors themselves.

Falls during the Erection, Alteration and Repair of Scaffolds

The prime purpose of scaffolds is to facilitate the work of building and to enable it to be done without undue risk; it is therefore incongruous that operations connected with the provision of scaffolds should lead to a substantial number of accidents, many of them serious. Six per cent of the falls of persons from heights, including 9 per cent of the fatalities, occurred to scaffolders. Accidents due to falls of materials were also numerous, 13 per cent of the accidents due to falls of materials from heights occurring during this work. Provision is seldom made for raising or lowering scaffolding components, these being almost entirely manhandled and passed or, quite commonly, thrown from one man to another. In addition, scaffolders often do not use for their own protection the safeguards they provide for other workers.

Accidents due to the collapse of scaffolds occurred all too frequently, these scaffolds including many erected by supposedly experienced scaffolders. Poor design, the omission of bracing members and the absence of ties which effectively prevent scaffolds moving away from the building on which the inner ends of the putlogs are supported, were among the more frequent causes of collapse. In one case, a tubular steel scaffold 50 feet in height inside an aircraft hangar collapsed like a concertina, due to inadequate bracing, although that was by no means the only constructional fault. In another case, a firm of scaffold contractors had erected around a three-storey building a putlog scaffold with a working platform at the top, from which repairs to the roof were made. The scaffold was tied to the building at the top only. When the man dismantling this scaffold was still working at a point 20 feet above the ground, several putlogs pulled out of the wall. This was due to a side load being applied to the scaffold by a gin wheel erected on one of the uprights. The man fell through the scaffold to the ground and suffered severe injuries, including a fractured spine. The accident clearly illustrates the necessity for intermediate ties to ensure the stability of the scaffold during erection and dismantling. A common case of failure of mobile scaffolds is overturning, primarily due to attempts being made to move or to restrain movement of the scaffold by a pull exerted by a person standing on the top platform. Easy access between the platform and ground level, chocking of

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the wheels or castors to prevent movement and sufficient counterweighting at the base to ensure stability are often omitted in the construction of such scaffolds.

The examination of scaffolds is sometimes done in a rather perfunctory manner and the entries in the register of scaffolding do not always give a true picture. On one site, for example, part of a scaffold collapsed three days after it had been examined and certified "in good order", no alteration having been made to the scaffold since that examination. There was one accident which could almost be described as a case of "justice": the foreman responsible for ensuring that the scaffolds were safe for use went on to a partially dismantled scaffold; the plank on which he stepped was not securely supported, overlapping its end support by 2 ft. 6 in. so that it tipped and he fell. That morning he had signed in the prescribed register that the scaffold was "in good order".

Falls from Trestle Scaffolds and Ladder Scaffolds

Almost without exception, when trestle scaffolds are seen in use, the supports are placed at a greater distance apart than that given as a guide in the Regulations. In a typical case, the distance between the supports was 8 ft. when it should not have exceeded 5 ft. A workman was at the centre of the span and his mate was standing close to one of the supports. Suddenly one of the planks broke and the workman fell to the ground, sustaining a broken heel. If the fabricated type of scaffold board were more commonly used for trestle work it would greatly help to prevent accidents due to the ordinary type of scaffold board being used over an excessive span. These fabricated boards can be fitted with guard rails and toe boards supported on uprights which are readily removable to facilitate movement of the scaffold.

Falls from Working Platforms of other Scaffolds

A complete absence of guard rails and toe boards at the edges of working platforms is seldom found nowadays on framed scaffolds, but insufficient attention is frequently given to points of detail. Guard rails are often removed unnecessarily or to a greater extent or for longer than is required to provide access for men or materials, and at ladder access points the gap in the fencing is frequently too wide. The use in the building industry of platforms with spaced boards has practically disappeared since the advent of the Regulations, but in the case of a fatal accident in a shipyard, a platform erected for building work had the planks spaced at intervals as is customary for shipbuilding stages. The man had been told to use additional planks to provide a close boarded platform, but he had declined to do so.

The use of makeshift platforms for the fixing of shuttering or reinforcement in concrete work is unfortunately all too common. The sizes of some pieces of shuttering create difficulties with regard to guard rails and toe boards, but far too much is made of these difficulties and many employers have not shown any determination to tackle the problem and devise practicable solutions. Serious and fatal accidents occur owing to the inadequacy of the platforms provided for this work. In one case, an injured person said he usually worked on a single plank, regardless of height, and that this had been his practice with a number of employers over a period of more than twenty years.

One accident is of interest as it pin-points a common failing. A man fell 14 ft. from an interior scaffold during the construction of a private house, the platform being about 5 ft. above open joisting for the ground floor ceiling.

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At the place where the man fell there was a clear drop to ground level. The builder concerned was fairly conscientious in complying with safety requirements, but he was surprised to learn that the requirements as to guard rails and toe boards applied to an interior scaffold.

Openings in Floors

These frequently have the fencing removed while work is proceeding at the edge, on the grounds that it is impracticable to proceed with the work with the guard rails and toe boards in position. It would be advantageous if in such cases a neat close-fitting cover could be provided for the opening, thus enabling work to proceed without risk. Such covers require, of course, to be sufficiently strong to support the weight of men as well as that of any other load likely to be placed upon them. Unless a cover over an opening is readily identifiable as such, adequate steps should be taken to render it so, unless it is so fixed in position as not to be readily removable. A boy was injured when he fell through a hole in a floor which had been covered by a sheet of corrugated iron. He had been told to clean up, and in consequence picked up the sheet and walked forwards into the hole. This "classic" accident shows the need for ensuring that coverings for holes are not mistaken for loose material.

Falls from Ladders and Stepladders

A large number of falls from ladders occur when the ladders slip because they are not secured. In most cases it is found that the injured person himself has erected the ladder and failed to secure it.

A ladder, even though secured and in perfect condition, is by no means a safe means of access to a height. Many accidents occur due to men falling off ladders for no other reason than that they lose their foothold while climbing or descending. A typical case of serious injury at no great height occurred when a man was stepping on to the rungs of a ladder at a height of 8 ft. above the ground. For an unknown reason his foot slipped and he fell to the ground, sustaining injury to his hip.

Defective ladders are all too common. A steel erector fell from a ladder while descending from a height. The man was carrying something in each hand — itself a dangerous practice — and as a rung was missing from the ladder he slipped and fell into a pit at the bottom of the ladder. In addition to the defect of the missing rung, eight other rungs had been replaced by lengths of piping, thereby introducing the undesirable feature of having dissimilar rungs in the same ladder.

Falls Through Roofing Materials

Despite much publicity, and efforts by Inspectors to spread the knowledge that asbestos-cement roofs are unsafe to walk or work on without crawling boards, serious accidents continue to occur. A carpenter was told to repair two broken asbestos-cement sheets on the roof of a temporary hut. He mounted a pair of steps at the back of the hut, and proceeded to remove nails which secured the sheeting to the wooden eaves, remarking to his young apprentice, "Be careful, you can fall through this stuff like lightning". Nevertheless, he placed one foot on the roof and another on the steps. The sheeting broke and he fell backwards on to the floor of the hut.

There have been frequent prosecutions for failure to provide duck ladders, crawling boards or other protection for roofs covered with fragile sheeting over which persons had to pass in the course of their work.

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Although they may be light in weight to facilitate handling, roof ladders should provide good foothold and be of adequate width. A width of less than 14 in. is not considered satisfactory. If it is easier to walk on the fragile sheeting, men will be tempted not to use the roof-ladders. In a number of falls through asbestos roofs, the duck ladders available were only 9 in. wide. In each case the injured person overbalanced from the ladders and stepped on to the roof covering, through which he fell.

Falls from Sloping Roofs

Roof-edge protection is commonly not provided and it has sometimes been found that no allowance for such scaffolding is made in the tender. In one case embracing the re-roofing of a large number of houses, the firm to whom the contract was awarded had made no such allowance. In consequence of a visit by an Inspector, however, roof-edge protection was provided and the extra cost no doubt so reduced the profit of the offending firm as to teach a severe lesson for the future. Unfortunately, such firms place reputable firms which allow in their tenders for the provision of scaffolding at a serious disadvantage.

Falls of Materials

Many of the accidents in this category involved injuries to the head, falling bricks, small tools and fragments of concrete being common causes. The wearing of protective headgear would undoubtedly have prevented such accidents. Such headgear is provided by certain firms but this practice is by no means widespread. Other accidents were caused by articles dropping on to the feet. This type of accident is on the increase and could be prevented by the wearing of safety boots. Rubber knee-boots are now being developed which incorporate flexible steel plates in the soles to prevent penetration of upturned nails into the foot, and such boots could also have steel toe-caps to protect the toes against falling articles.

Lifting Appliances (*other than Hoists*)

Lifting appliances, although responsible for only 2 per cent of all building accidents, create a serious hazard unless properly installed, expertly handled and carefully used. Each year brings its toll of spectacular accidents such as collapses and overturning of cranes, as well as accidents in which other appliances are involved. Cases of overturning of rail-mounted travelling tower cranes, now common on building sites, have occurred; one of the principal causes of such accidents is the failure to provide a really firm and level rail track for the crane. A contributory cause of collapse may be the use of these cranes on curves of small radius. In one case early in the year, a crane carrying a load within its capacity was negotiating a curve of a radius not less than that recommended by the makers' agents as a minimum when it toppled over. The rails were laid on sleepers which rested in turn on ground which had been made up with ballast; in the course of time, the sleepers had begun to work up and down in the ballast and it seemed likely that overturning was due to excessive deflection of one rail of the track, as well as to the fact that the wheel flanges rode up on the rail as the crane travelled round the curve. Both the wheel flanges and the rail were found to be worn away to an angle of 45°. Maintenance of a firm bed for the sleepers and frequent packing up with well-rammed ballast is essential where cranes operate on rail tracks.

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Competence of the driver is a very important factor in the safe operation of cranes. A serious accident occurred to a crane driver who was trapped by the jib when his crane overturned. The crane, which was of 15 cwt. capacity, was being used to lift buckets of rubble, but on one occasion the jib failed to slew when the slewing lever was engaged. The driver, assisted by the signaller, was trying to slew by pulling on the jib, when the crane overturned, injuring the driver. The driver had had practically no experience and had not been trained. In fact, he was new to the building industry and had formerly been a "barrow-boy". In view of the circumstances of the accident, the contractor was prosecuted for employing a person to drive the crane who had not been trained and who was not competent.

Sub-contractors responsible for the installation of concrete floors, steel-work, and roofs composed of decking slabs, frequently use timber derricks which are rarely of sound construction when erected for use. The typical arrangement consists of a vertical wooden pole some 20 ft. in length, having a pulley block lashed on to its upper end, another pulley block at the base guiding the winch cable, and four guys from the top of the mast; a "kicking" wire to balance the winch force at the base completes the arrangement. The hook on the lifting rope is seldom of safety pattern, guys are frequently taken across sharp corners without protection, and guys and lifting ropes are rarely correctly made-off. In one instance, a board and a number of loose bricks wedged between the winch and the base of the mast fulfilled very doubtfully the function of a "kicking" wire. Familiarity of the workers with such arrangements aggravates an already dangerous situation. The basic fault, however, rests with the firms supplying this material in the first instance.

Hoists

Accidents on hoists amounted to rather less than 1 per cent of all accidents. The Regulations are intended to prevent injury to persons due to being struck by the cage in motion or due to falling down the hoistway, but, notwithstanding the low standard of compliance with these requirements, the number of these accidents is not large. This poor compliance is largely due to the failure of the workers using the hoist to close the gate at the landing position before the platform is moved away. In one such case, proceedings were taken against a ganger in charge of the gang laying concrete on a flat roof 30 ft. above the ground. He himself was operating a barrow hoist used for bringing up the concrete. The operation was seen by an Inspector when visiting a nearby factory, who noticed that the hoist gates were not being used. He visited the site half-an-hour or so later and found that the hoist was still in operation but that the gates were not being used by the ganger. The contractor had taken a lot of trouble to ensure compliance with the Regulations and it was decided to prosecute the ganger. A conviction was obtained.

The provision of gates is by no means universal, but there is little doubt that the workers could make more use of them. An interesting development which is simple and successful is the use of flags attached to the gates of the hoist enclosure. The platform hoist in question serves the floors of a newly-constructed eleven-storey block of flats and the driving position is at the top, adjacent to the hoist tower. When all the gates of the enclosure are closed, the driver has a clear indication, by the line of flags down the side of the hoistway, that this has been done. Should a gate be open this is immediately apparent by the gap in the line of flags. The driver is under strict instructions not to operate the hoist if a gate is open.

In order to avoid the provision of gates up to the full height of 6 ft. 6 in., some firms tend to provide fencing of lesser height out of reach of the moving

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hoist. In such a case the landing must extend within the fencing up to the edge of the hoistway. An accident occurred at such a hoist when a ganger fell down the hoistway. The guard rails were sufficiently far from the hoistway to allow a two-plank platform between them and the hoistway. The ganger remained on this platform when the hoist had gone away. One of the guard rails was loose. He depended on it for support and fell down the hoistway.

A type of accident which is on the increase and which often results in serious injury is caused by what is tantamount to the free dropping of the hoist platform while persons are on it. The common factor in all the cases which have come to notice is that the winch drum had by some means been kept in such a position that it was not in effective contact with either the brake-band or the friction drive. In some cases this occurred because the driver consciously or unconsciously kept hold of the control rope, while in others the control rope was caught by some part of the scaffolding. In only a few of the accidents was it definitely established that the men injured were riding on the platforms at the time; the men concerned were mostly loading or unloading in a normal manner.

Small firms sometimes purchase old barrow hoists from larger contractors, who may wish to get rid of them because they are wearing out. One case, probably worthy of note, is that in which a barrow-hoist rope broke as a workman on the platform, 20 ft. above ground level, was about to wheel a barrow-load of bricks on to the scaffold. The platform crashed to the ground because the safety cams failed to operate. The hoist had been purchased second-hand and the firm had made considerable efforts to find out their obligations; they had consulted the previous owners for advice on maintenance, but without success; they then wrote to the hoist makers, but all they received was a lubrication chart and spares list; finally the matter was taken up with the firm's insurance company, and they replied briefly that the hoist was covered by the policy. The one thing which the firm did not do was to consult a Factory Inspector.

Machinery Accidents

Accidents from the use of machinery naturally form a smaller percentage of the total accidents in the building industry than they do in the manufacturing industries, but nevertheless the number is substantial, amounting, apart from accidents with lifting and vehicular equipment, to over 1,200 per year. In the case of machines supplied subsequent to 1948, the supplier is under an obligation to provide guards for certain specified dangerous parts, and if that obligation were observed on all new machines, the number of accidents would be substantially reduced. The user is under an obligation to guard not only these specified parts but all other dangerous parts, and also to maintain the guards in an effective condition. Machinery guards on building sites must be robust and so arranged as not to admit of easy displacement. Guards consisting of hinged covers which can easily be opened are frequently left open, so that the protection which the designer intended them to provide is largely lost. Unless a dangerous part is so guarded as to prevent deliberate approach, accidents are almost certain to happen.

Cement-mixers caused two not unusual accidents. A seventeen-year-old labourer was attempting to put a sheet of metal under a cement mixing machine and placed his hand on the trunnion arm. One of his fingers was crushed between the trunnion arm and the rotating drum. In the other accident at a cement mixing machine, a man slipped and his forefinger was slightly injured when it was trapped between the unfenced drum ring teeth and pinion.

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A worker was killed on the flexible shaft transmitting the drive from a tractor to the hydraulic mechanism of a mechanical shovel. Danger from flexible driving shafts is quite common on mobile plant, and represents a serious risk both in building work and in agriculture. It transpired that this shaft was not normally guarded on these machines, which are used mainly in places not subject to the Factories Acts ; however, the makers were approached and made arrangements for guarding on future machines.

Accidents in Excavation Work

In building work, accidents due to the collapse of excavations are not so numerous as on works of engineering construction, but a substantial number in fact occur and the most serious results can be expected, even in cases where, except to an experienced person, the risk seems very small. As with fragile roofing materials, the danger is not immediately obvious, and work is often allowed to proceed without proper precautions being taken. A fatal accident happened when the retaining wall at the side of a trench collapsed and, together with rubble which had been filled in behind it, buried a worker, who died before he could be extricated. The 9-in. wall was not of itself sufficient to retain the rubble and the construction was, in fact, incomplete at the time of the accident. Prior to the accident, the weather had been very wet and rain-water appears to have drained into the spaces between the rubble, thus exerting an additional pressure on the wall.

Demolition Work

Demolition is a specialized job, but even so, care and expert supervision is essential throughout the whole course of the work. Spectacular collapses, used as a rapid means of attaining the ultimate goal, are likely to lead to disaster unless the most careful preparation is made beforehand to ensure that the course of the operation is understood and is under control. Demolition should properly be a reversal of the process of erection, each stage being completed in orderly fashion so as to ensure that no part of the structure is left insecure before the next stage is started. Adequate precautions should be taken to ensure the safety of those employed on the work.

Accidents frequently happen when the work is being carried out by inexperienced persons. A serious accident occurred when the 9-ft. high first floor of an old farmhouse collapsed. It was found at the time of the investigation that the main beam supporting the floor joists was riddled by woodworm. The condition of this beam was so obvious that any person using a grain of common sense would have taken some precautions. The general foreman, however, had allowed the men to work from this floor when demolishing the external walls.

A fatal accident occurred when a bricklayer employed by a large engineering firm was demolishing a brick furnace. The brickwork was supported by large cast-iron stays with stiffening ribs. These stays were let into the concrete base along the sides of the furnace. The back wall of the furnace had been built against the wall of another building and there the stays had not been let into the base ; the builders of many years ago had apparently considered it sufficient that these stays should be merely sandwiched between the two walls. At a prior inspection some time before, the chargehand had found the outside stays to be let into the concrete base by some 18 in. Although he could not see them and had no means of examination, he had assumed that the back stays were likewise secured. The arch and side walls were demolished and one set of stays successfully removed. When most of the back wall had been removed, the back stays suddenly fell in, killing the bricklayer.

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A small painting and decorating contractor found, during the hard weather of last winter, that he could not paint outside, and was therefore short of work. From the local council he obtained a contract to demolish certain old houses; without knowing anything of demolition, he began work on the houses, which were more than 200 years old. After the roof had been removed, he set to work with one of his men (a lorry driver) to remove the floor-boards from the bedroom. Suddenly, the chimney brickwork from floor to apex of the building collapsed inwards and buried the lorry driver. He was lucky to escape with nothing more than a broken leg. The chimney brickwork was not tied to the end-wall of the house; an experienced demolition worker would have been on the lookout for this, and would have taken steps to prevent such a collapse.

When another accident happened, a private house was being demolished. The roof, ceilings and floor-boards in all rooms had been removed. Four men were working on the first floor, standing on the joists and pushing over the inner single brick partition walls in the bedrooms to allow the brickwork to drop into the cellar below. Some of this work had been done successfully but, as the men were pushing the remaining wall of a small bedroom, one of the side walls collapsed on top of them. Three of the men escaped with minor injuries but one sustained serious injuries involving several broken bones. The work was in charge of an experienced foreman, who was one of the men involved in the accident. The men had taken the precaution of cracking the side wall at the corner adjoining the wall being pushed over, thus separating the two walls. However, they overlooked a strip of metal bonding linking the walls and it appears that this was responsible for the unexpected collapse of the side wall. This form of metal strip bonding is not often found in house construction and it was a point overlooked by the foreman.

Another fatal accident occurred when a permanent way railway inspector and two of his men set about demolishing a cottage of which only the gable walls, and the outer walls to a height of 4 ft., were still standing. Their method of demolition was to poke at a wall at a height of about 6 ft. with a crowbar. The two workmen managed to demolish one gable wall without incident; this was remarkable as the wall was 20 ft. long, 15 ft. to the eaves and 18-21 ft. high where the ridge had been. In demolishing the other gable wall, one of the workmen was unable to get out of the way when it fell; he was fatally injured. Neither the inspector nor the workmen were experienced in demolition and no safety precautions of any kind had been taken.

Rivet Firing Guns

The risks involved in the use of the explosively actuated rivet gun are more appreciated now than when these tools first came into use a few years ago. One maker has instituted a course of training to which employers can send men who are to be authorized to use the gun; a certificate of competency is issued after such a man has attained the required standard of proficiency. One firm using the guns on a fairly large scale has arranged with the makers to send a representative, capable of training men, to each site where the gun is to be used. Only one or two men are trained on each site and these are the only ones allowed to use the guns. The gun itself is kept under the personal control of the agent. Accidents which have occurred with these guns include a case in which a man attempted to remove with a nail a cartridge which had misfired and stuck in the breech. The cartridge exploded and blew off part of the man's thumb. The design of these guns should incorporate a cartridge ejector. In another case, a man who had been fixing timber battens to concrete in a very restricted space was found shot through the head. The

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safety device on the gun he had been using was found to be not only poorly maintained but only partly effective when in good condition. It seemed likely that the gun went off when it was accidentally dropped on the floor, the bolt projectile killing the operator. In a further case, timber battens were being fixed to a concrete wall when a small lump of concrete behind one of the battens broke away. This caused the batten and gun to slip, the gun fired and the fixing nail went through the operator's wrist; this type of accident can be avoided by proper design of the gun-firing mechanism, which should prevent a shot being fired unless the gun is held firmly in contact with and at right angles to the surface into which the nail is to be driven, the pressure being exerted equally round every part of the protective skirt.

Mechanically Propelled Vehicles

Accidents due to mechanically propelled vehicles are on the increase, and this, though regrettable, is understandable in view of the tremendous increase in the use of mechanical aids. More attention will have to be paid to systems of work and to the training of drivers if accidents are to be avoided. In two cases, dumpers overturned and caused injury to the drivers. The work is often done by a labourer not in possession of an ordinary driving licence and having little training or experience. More skilful drivers would probably have avoided both the above accidents.

When a mobile crane was being moved to a fresh locus, the ground gave way under one caterpillar track and the crane toppled over. The roadways and tracks on building sites are not maintained in the same state as public roads and the possession of a driving licence is not a sufficient criterion of efficiency for driving on building sites. Training and instructions are essential. Roads and tracks and dumping places of a temporary nature should be kept under constant and competent observation and maintenance. The employment of signallers at places where several vehicles are engaged in loading or unloading should be considered, as the vehicles and their loads often obstruct the drivers' vision.

Works of Engineering Construction

The total number of accidents reported from the classes of operation which are defined in the Factories Act, 1937, as works of engineering construction was 2,012, and this figure includes 39 fatalities. A comparison of these figures with those of previous years is given in Table 23, which also shows the ratio of fatal to total accidents on a percentage basis.

TABLE 23

ACCIDENTS AT WORKS OF ENGINEERING CONSTRUCTION, 1950–55

Year	Total Accidents	Fatal Accidents	Ratio: Fatal/Total Accidents—per cent
1950	2,274	47	2·07
1951	2,116	37	1·75
1952	2,379	54	2·31
1953	2,182	52	2·38
1954	2,172	42	1·93
1955	2,012	39	1·94

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In addition to these, a number of accidents were reported from operations which, while within the class of work undertaken by the civil engineering industry, are not included in the definition of works of engineering construction. The number of these accidents was 254, including 7 fatalities. Such accidents are not statutorily reportable and this figure cannot therefore be assumed to represent the accidents happening on operations in the civil engineering industry which are not within the scope of the Act.

Table 24 gives a detailed analysis of the accidents reported from works of engineering construction.

In the preparation of Table 24, no account has been taken of the 254 accidents on civil engineering works of which notification was sent to the department although they were not statutorily reportable. It is clear, however, that many accidents occurring on works of engineering construction (which are therefore reportable) are not in fact being reported. Some of the smaller contractors, particularly those undertaking maintenance work, are omitting completely the notification of accidents.

That important work can be carried on without incurring risk was demonstrated in a major scheme of dock reconstruction which was completed in a period of twelve months without an accident of a serious nature.

Reports from Inspectors indicated great activity in the industry; specific classes of work mentioned include the construction of bridges, sewers, sewage works, tunnels, water mains, gas-holders, jetties, reservoirs, piers and docks, as well as maintenance work on harbours, docks and sewers.

TABLE 24

WORKS OF ENGINEERING CONSTRUCTION:

ANALYSIS OF ACCIDENTS BY CAUSATION, 1954 and 1955

Cause of Accident	Percentage of all Accidents			
	Falls of Persons		Falls of Materials	
	1954	1955	1954	1955
1. FALLS OF PERSONS OR MATERIALS				
(a) From scaffolds during erection, alteration or dismantling	0·32	0·20	0·37	—
(b) Falls from scaffolds in use as working platforms, gangways, etc.	1·43	1·32	0·52	0·25
(c) From ladders (including stepladders)	1·10	1·17	0·37	0·45
(d) Through openings in decking, floors or walls	1·29	0·81	0·10	—
(e) During work on slopes	0·74	1·17	0·18	0·20
(f) From structures during demolition	—	0·10	0·23	—
(g) Into shafts, excavations, etc.	3·18	2·96	1·30	1·63
(h) From working places other than above	1·70	1·53	1·58	3·00
(j) Other—from heights—unless classifiable under 2, 3 or 5	1·85	2·85	1·75	2·76
(j) Into water—with risk of drowning	0·55	0·51	0·05	0·05
(k) On the flat:—				
(i) due to obstructions, overlapping boards, etc.	1·02	2·90	—	—
(ii) Other	2·82	1·83	1·15	—
TOTALS	16·00	17·35	7·60	8·34

(Table continued on next page)

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TABLE 24—*cont.*

Cause of Accident	Percentage of all Accidents 1954	1955
TOTAL FALLS (brought forward)	23·60	25·69
2. EXCAVATIONS AND EARTHWORKS (other than tunnels)		
(*a*) Buried or partially buried by collapse of side	2·08	2·75
(*b*) Struck by material falling from side or edge	2·82	0·71
3. TUNNELLING		
(*a*) Buried or partially buried by fall of material from top or sides ...	0·14	0·20
(*b*) Struck by material falling from top or sides	1·90	1·98
4. MACHINERY		
(*a*) Power operated	3·76	3·66
(*b*) Other	2·12	0·05
5. LIFTING APPLIANCES AND LIFTING GEAR		
(*a*) Cranes (i) Overturning, failure of anchorage, etc.	0·74	0·81
(ii) Failure of structure	0·23	0·05
(iii) Failure of mechanism (including ropes, chains, etc.)	1·43	0·81
(iv) Other causes	2·50	2·39
(*b*) Excavators and Draglines	0·65	1·04
(*c*) Hoists (not cage operated)		
(i) Fall of platform or cage	—	—
(ii) Fall of material from landing or platform	0·14	0·10
(iii) Trapping by hoist	0·51	—
(iv) Other	1·06	—
(*d*) Lifting Appliances in use for hoisting persons		
(i) Hoists	0·14	—
(ii) Other appliances	0·05	0·20
(*e*) Other lifting appliances (failure of appliance or part)	—	1·44
(*f*) Failure of ropes, chains or lifting gear (not forming part of a lifting appliance)	0·14	0·10
6. USE OF EXPLOSIVES	0·51	0·76
7. STEPPING ON OR STRIKING AGAINST OBJECTS (except falls)		
(*a*) Protruding nails	3·36	2·90
(*b*) Other	2·86	3·52
8. CARRYING, WHEELING, MOVING OR LIFTING BY HAND (except falls)		
(*a*) Cuts, bruises and abrasions	7·38	11·50
(*b*) Strains, ruptures and fractures	9·06	12·72
(*c*) Other	2·91	1·07
9. USE OF HAND TOOLS		
(*a*) Power driven	2·40	3·72
(*b*) Other	4·53	8·90
10. MECHANICALLY PROPELLED VEHICLES		
(*a*) Earth-moving equipment	1·75	3·46
(*b*) Other	2·59	1·24
11. LOCOMOTIVES AND WAGONS	3·23	3·56
12. GASSING, ASPHYXIATION, ETC. (except where due to being buried)	0·09	0·35
13. MISCELLANEOUS	15·32	4·32
TOTAL OF ALL ACCIDENTS ...	100·00	100·00

As in previous years, the largest causation group was that of falls of persons and materials, in which approximately one-third of the accidents were caused by falls of materials. In 12 cases, the persons who fell sustained fatal injuries and 4 of these fatalities were due to falls into shafts and excavations. Falls of materials into shafts should be prevented by protecting the shaft at points at which materials liable to fall might gain entry to it. The danger of materials being lowered on to persons who might emerge from a tunnel at the bottom of a shaft was provided against at one site by a safety device which automatically signalled to the crane driver or winch operator at the top of the shaft the presence of workmen at the bottom of the shaft. At about 30 ft. inside the tunnel was a signal, operable by hand or by a bogie in motion, which lit a red light at the top of the shaft. This light remained at red until put to green by someone below.

Reports from all over the country referred to frequent collapses of sides of excavations, especially of trenches. There is no doubt that this is a very real and serious risk. In many cases, even after collapses causing serious accidents had occurred, some contractors appeared to pay no great attention to the need for timbering. The fatality rate from this cause is very high, there being one fatality for every 6 persons injured.

Falls of Persons

Persons undertaking a work of engineering construction are under no statutory obligation to make reasonable provision to prevent accidents. Although in many cases care is taken to see that the precautions specified in the draft code of Regulations for works of engineering construction are carried out, this practice is by no means universal. In the case of a new gas-holder which was being erected, one of the workers, while attempting to reach a catwalk from a small bracket scaffold at the edge of the holder, failed to get a handhold and fell a distance of 26 ft. to the ground. No guard-rails were provided either for the scaffold or for the catwalk. Another example of failure to reach the standard indicated by the draft Regulations was the case of a steel erector; he was bolting roof-trusses to a prefabricated centre unit of a digestor tank and, in stepping back, trod on a bolt lying on a narrow ledge and fell some 30 ft. into the tank, sustaining a fractured arm and pelvis. Three-quarters of an hour elapsed before he could be lifted out, owing to the woeful inadequacy of the first aid provision. Instructions for emergency treatment had to be shouted down from the top of the tank by a woman trained in first aid who happened to be at hand. A sling stretcher, such as is proposed in the draft Regulations, would have facilitated the rescue work but was not available.

The collapse of the arch of a road bridge in the course of demolition shows that persons in charge of this class of work sometimes omit to take steps to prevent premature failure of the arch ring. The bridge was of brick construction, 16 ft. wide, with a 3-course ring of brickwork rising from vertical abutments. No special care was taken to remove the filling equally from both sides of the arch, neither was the underside of the arch supported in any way. While two men were taking off the top course of the arch brickwork, the arch collapsed without warning and the men fell into the river below. The demolition of structures should be carried out in reverse order to the constructional operations; this is especially true of arches, which should be temporarily supported before they reach an unsafe state.

Excavations

In one case, two men were killed by the collapse of the side of an excavation 10 ft. deep. The material excavated consisted of sandy clay to a depth

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of about 5 ft., resting on wet sand. Men with even limited experience should have known how treacherous such material can be, but no shoring was provided, although some parts of the face had been battered back to a slope of about 10 to 1. Such a slope was obviously too steep to ensure stability and, although a collapse had occurred some days before the fatal accident, men were still put to work in the excavation. After the second fall had occurred, with its tragic results, the person in charge still appeared unconvinced about the need for timbering. Such accidents are constantly occurring because men of experience fail to realize that their judgment may be wrong, and in some cases seem unable to learn even from their own experience.

No chances whatsoever can be taken in trench work and means must be found in every case to ensure that men do not for any reason expose themselves to risk in an untimbered portion of trench. A man sustained severe rib and lung injuries when the 10-ft. deep sewer trench in which he was working collapsed. Investigation revealed that he was working a little ahead of the existing timbering, measuring up for the next cross-pieces. When he saw the trench begin to fall, he stepped back into the timbered part, but forgot that there was a cross-piece immediately behind him. The fall of earth pinned him with his back against this cross-piece, causing severe injuries. This was clearly a case where there was no real need for him to be in the untimbered portion of the trench.

One accident, which happened to a man who should have known better, occurred during the removal of timbering from a sewer trench. The person involved was the charge-hand and he was removing the last struts by standing inside the trench, when one side of it caved in. It should be an invariable rule that no one should be in a trench, whether erecting timber, working, or removing timber, unless there is sufficient timber in position to prevent a fall. The first poling boards should be put in and the last poling boards taken out by working from the surface. Where the latter cannot be done, the trench should be back-filled until the depth is such that it can be entered safely. Alternatively, the timber should be left in position.

Lifting Appliances

A notable feature in accidents at works of engineering construction is that the proportion of accidents involving cranes is higher than it is in building operations. This result may be partly attributable to the statutory obligations imposed for safety by the Building Regulations, but, on the other hand, the crane accidents at works of engineering construction are more frequently of an operational nature than arising from mechanical faults in the plant. Three men were injured when a skip containing the men was being lowered in a shaft and the descent was too rapid to be adequately checked by the brake alone. The brake was found to be in order and the accident occurred because the lowering was being done with the clutch disengaged. There were also cases of head injuries inflicted by skips which were being manoeuvred into position by crane-drivers working in the open with full visibility. Another example of an operational error is the case of a digger-operator striking a trestle scaffold with the bucket, causing a labourer working on the scaffold to fall to the ground. In all these instances, the onus lay on the machine-drivers to work the machines safely, but they took risks involving the safety of others in order to speed up output. No standard remedy can be devised to prevent such occurrences but a careful investigation of such a driver's previous record might show that he was not a careful driver and had not been employed for long by any single contractor.

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The misuse of a crane by a driver, who was well aware of the risk he was taking, fortunately did not cause injury. The crane was mounted on a barge lying alongside a jetty on which repairs were being carried out. The barge had to be moved a few yards upstream, so the driver attached the crane hook to one of the piles he had already driven and attempted to move the barge by applying the power to the inclined hoisting rope. Under this force, the derricking rope snapped and the jib crashed down on the deck, fortunately without injuring anyone. Winches were available to move the barge but, owing to its position, snatch-blocks would have had to be used and to avoid the trouble of rigging these up the men concerned took the serious risk of using the crane in a manner for which it was never intended.

The need for maintaining safety devices in an efficient state is shown in the case of a mobile crane which was being used at a river-front. The crane was lifting a floating stage when it overturned and fell into the river. Afterwards, the connecting arm between the jib base and the automatic safe working load indicator box was found to be badly bent and in consequence the indicator had been giving incorrect readings. The load was considerably in excess of the safe working load for that particular radius but the indicator, because it had not been maintained in an efficient state, failed to give warning of the fact. Another point which emerges from this accident is that at the commencement of lifting a load out of water the pull on the crane will be appreciably less than the weight of the load in air. A crane may, therefore, overturn when supporting, clear of the water, a load which it has without difficulty raised from a position in the water.

Machinery

A man assisting in excavation work met his death while dealing with spillage from a belt conveyor forming part of a dredger-type excavating machine. The material falling from each side of this conveyor was piling up on the edge of the excavated trench in such a way as to interfere with the progress of the work, and two men were detailed to shovel it back into the trench, moving along as the excavator progressed. While doing this work, they stood close to the moving buckets of the excavator and one of the men was caught, either by the buckets or by the chain on which they were mounted, and dragged into the trench. This type of accident was referred to in several reports and it is clear that it is a real risk with this class of equipment. Workers should avoid getting into too close proximity to conveying, elevating and digging equipment which is necessarily exposed for the purpose of the work and the method of working should be organized so as to ensure that no person should run this risk.

Although the proposed Regulations for works of engineering construction contain requirements which would place obligations on machine makers similar to those already in force with respect to machinery supplied for use on building operations, machine makers often fail to consider the safe operation of their products. A typical accident occurred to a man who suffered injury when he slipped on muddy ground and his fingers were caught between an uprunning pump-engine fan-belt and the strut joining the radiator unit to the engine. This unprotected belt passed within two inches of three of the engine controls and, although it was a simple matter to provide protection, no provision for this had been made in the design. The unguarded fan blades on this engine were another hazard adjacent to the engine controls.

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Transport

The dangers attendant on the use of mechanical transport in the construction of tunnels have been made evident by a number of accidents on the hydro-electric schemes in Scotland. In these tunnels, the narrow-gauge locomotives, skips and loaders provide the means of removing spoil from the working face and also convey the personnel to the working places in the tunnels. Work at the rock-face is inevitably arduous and the cramped space in which the work must be done increases the risk of accident. Likewise, along the length of a tunnel, the close confinement increases the risk of injury in the event of a minor mishap of a kind that would be unlikely to inflict personal injury if it occurred in the open. Thus, the derailment of a bogie and the otherwise simple job of setting it on the rails again in the cramped, possibly wet, and generally arduous conditions which obtain in the tunnels of a hydro-electric scheme is much more likely to lead to an accident than is a similar mishap in an open site.

Gassing

The danger of entering confined spaces in which the atmosphere may be poisonous or deficient in oxygen is not always realized, but there is little excuse for running an internal combustion engine without provision for its exhaust fumes being discharged to the open air. Three men were gassed when a pump driven by a petrol engine was set to work in a pit 18 ft. long, 12 ft. wide and 38 ft. deep on the site of a sewage works.

Accidents in sewers due to gassing were the subject of an investigation by an inter-departmental committee in 1933; based on the findings of that committee* a report was drawn up by a committee† of the Institution of Civil Engineers, making recommendations about the use of breathing apparatus in sewers. The need for precautions is underlined by three gassing cases which took place during the year in the course of sewer repairs. It has been said that because sewer maintenance men enter sewers daily without being overcome, a lack of appreciation of the risks has grown up. Reference to the two publications mentioned should remove any doubt about the need for precautions.

Explosives

The use of explosives for blasting caused a few accidents, including two fatalities. Both the fatalities occurred when charges exploded prematurely during stemming. In another case, five men were injured by an explosion which occurred when shotholes were being drilled. This was clearly a case of a drill coming into contact with an unexploded remnant from the last set of charges to be fired. Even when a set of charges seems to have fired perfectly, a small fragment of charge may have been cut off by rock movement and left undetonated. In this case, the charge had not been detected during the routine inspection of the face before drilling was recommenced. In order to prevent the recurrence of such accidents, a more rigorous inspection procedure was instituted, involving the detection and investigation of all sockets left in the face after the firing of charges.

Adequate warning of blasting is essential to enable people to take cover, and the importance of ensuring that the protection afforded is adequate is illustrated by two accidents which occurred when blasting was being done in the open. In one of these accidents, a man who had taken cover behind a

* "Accidents in Sewers" published by H.M. Stationery Office.

† "Recommendations in regard to Breathing Apparatus for use in Sewers" published by The Institution of Civil Engineers.

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shed was injured by a piece of rock which flew over the top of the shed and fell on his shoulder. The second man, a ganger, had withdrawn to a place, which he deemed safe, nearly 200 yards from the place where the shot was fired and yet he was struck on the leg by a flying fragment of rock. These accidents serve to illustrate the unpredictable behaviour of rock shattered by explosion and they underline the need for the most stringent precautions where blasting is being done.

Miscellaneous

The general adoption of safety helmets by a certain class of road user and the preparation of a British Standard laying down the requisite performance for industrial safety helmets*, coupled with their more ready availability and their less forbidding appearance, has promoted their use on many constructional operations. In some cases, employers virtually insist on the wearing of safety helmets. As an example of their value, it is reported from one large site, where a 2-ft. gauge railway was in use, that a man's head was trapped between a train of trucks and a mobile shovel. The injuries might have proved fatal but for the fact that he was wearing a safety helmet.

On construction contracts risk of drowning frequently exists. An accident which, but for the effective precautions taken, might have had serious consequences occurred during work on a new road bridge. A crane-driver had climbed to the cab of another crane to have some discussion with the driver. On his return, he stepped on to a side section of the bridge, missed his footing, and fell 110 ft. into the river below. Fortunately, the level of the water was high and he was picked up immediately by the duty boatman. A similar accident occurred at another site where contractors were repairing and extending a pier. A worker was using a portable electric drill and apparently the tool caught in his trouser leg, causing him to lose his balance and fall into the sea. He also was picked up by the boat which was standing by for such an eventuality.

Arrangements to prevent a person from drowning cannot, however, be regarded as a substitute for fencing to prevent a person falling into water. This is illustrated by an accident during the repair of a jetty ; a man fell from a platform just above water-level into the river, which was about 15 ft. deep at that place. The man had previously fallen in at the same spot and had proved himself to be a strong swimmer, but on this occasion he did not come to the surface, and, despite prompt rescue attempts by two other strong swimmers, his body could not be found. It was eventually found several days later about three-quarters of a mile downstream. Undoubtedly some consequence of his fall had rendered him unable to swim. This fatality could only have been prevented by preventing the fall.

* B.S.2095—Industrial Safety Helmets.

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PART II. HEALTH

CHAPTER 11

Health — General Observations

ALTHOUGH industrial processes are becoming all the time more complicated and in many cases the hazards have increased proportionately, it would be fair to say that measures taken for the well-being of the workers have certainly improved. Better working conditions, side by side with the advance of new processes, have reduced the exposure to risks due to toxic substances. Much of this has come about because of an increased awareness on the part of enlightened managements of the need for good working conditions as a means of keeping their employees healthy and happy and as a way of cutting down absenteeism. With full employment they find it hard to get staff in competition with the newer factories unless they provide facilities of an equal standard.

On the advice of the Industrial Health Advisory Committee, two surveys have been inaugurated, one to review conditions in all factory premises in Halifax, and the other to survey a single industry, pottery having been chosen for this purpose. The general and lively interest in industrial health is indicated by the willing co-operation which has been received from all concerned in each of these surveys, the results of which are not yet available.

Before mentioning other factors relating to health, a report from the Stoke District on one of the oldest industries may be quoted as indicative of the changed attitude which is everywhere apparent in industry today.

"Occupational health has always bulked large in the work of the Department in the Potteries, and especially in relation to its staple industry. There has, however, been a subtle but recognizable change of attitude to health risks over the past 15 years. In the period immediately before the Second World War, the Inspectorate was chiefly fighting a propaganda battle. Many employers, managers and workers in the industry were concerned about risks of lead poisoning and of silicosis, but, on the whole, active concern was limited to a small group. Many employers gave only perfunctory recognition to health risks and employed persons were often largely unaware of the risks to which they were exposed. The war and post-war years have brought about a marked change. Employers and managers are coming to realize that the health risks of the industry are not merely incidental, but are something which may determine the future of the industry itself. Everyone has become more aware of dust risks; a very important expression of this concern with dust has been the active work of the British Ceramic Research Association on dust prevention. The officers of the Association recognize that this is a problem as vital to the industry as are problems of production and, with very few exceptions, the members of the Association have fully supported this point of view.

Annual Report of the Chief Inspector of Factories (1955)
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"Apart from the processes with special health hazards, the general campaign for cleaner conditions continues throughout the industry. Perhaps the most noticeable change of recent years is the great improvement in the state of floors and, in consequence, in general cleanliness. In spite of some problems and difficulties, the vast majority of potteries have now put in impervious floors. According to the latest information available, there are now only about five potteries which have not yet secured full compliance with this requirement and in most of these cases work is reported to be well in hand. Another noticeable improvement, which is perhaps less relevant to health, but which is a real contribution to the comfort of workers (and, incidentally, of Inspectors) is the great improvement in the state of works yards. It is now possible to return from night inspection of potteries without the appearance of having walked over a ploughed field.

"There is little to add to what has been said in previous years about methods of cleaning. According to our records, vacuum cleaning plant has now been installed in about 100 potteries. These vacuum cleaners are useful in cleaning beams and ledges, but it is still open to question whether they are better than mopping and swilling for floor cleaning. The portable type of cleaner may well be as great a health hazard when it is in operation as is brushing, because of respirable dust passing through the collector. The built-in cleaning system, with air-discharge to the outside, is obviously a far better system, but very costly. It seems probable there will be an increase in the use of vacuum cleaning plant, if only because of the difficulty of recruiting 'night sweepers' in a period of full employment.

"A special health problem, which has come to notice during the past year, has been that of exposure to very high temperatures during emergency work on tunnel ovens. This is a result of the widespread increase in the use of tunnel ovens in the potteries. These ovens operate continuously and the economics of the industry depend on the operation not being interrupted. Occasionally, while a truck is going through the firing zone of the oven, the ware or its supports may break and the truck and broken ware will jam. In these cases, there is a very strong financial incentive for the firm to try to clear the blockage as quickly as possible. It is very difficult to estimate the temperatures encountered during this work. Managers talk of temperatures of 200° to 400°C. and, while it would obviously be impossible for a person to live in such a temperature, which is well above the boiling-point of water, it seems possible that workers doing this emergency work may be exposed to very rapid fluctuations of heat. Several workers have spoken of the importance of keeping their heads covered, so that their hair should not catch fire, indicating local exposure to very high temperatures. The problem came to light chiefly as a result of the Chief Fire Officer of the City questioning the suitability of the asbestos suits which are sometimes used for work of this sort; he suggested the risk of heat collapse if a suit heated up and the worker were unable to get out of it quickly enough. Further investigation showed that, whereas some firms were strongly opposed to using asbestos suits, others kept them in stock and inexperienced workers could rely on them in an emergency. One factor in the problem is that blockages occur rarely in any one factory but, when they occur, there is a risk that men who are not experienced in hot work and are, perhaps, not physically fit, may try to cope with the emergency. Various technical and medical problems are involved, including the maximum temperature to which a person may safely be exposed, the effects of inhaling hot air, forms of protective clothing and breathing apparatus, and the selection of persons to do this work. While firms make every effort, by careful setting and in other ways, to avoid the

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need to enter these hot places, such emergencies are unavoidable on occasions. The problem has been discussed with the Medical Inspectorate, and with the Research Association of the Industry."

Temperature, ventilation, lighting, welfare amenities and medical supervision, as being all-important to the well-being of the factory worker, have received attention in separate chapters of this Report.

Cleanliness

Many more firms now realize that cleanliness is of paramount importance in promoting health and efficiency in industry and that it must therefore be the concern of all from the higher management downwards. The average standard of cleanliness in factories is therefore slowly improving, although black spots remain. The cleaning of floors in common passageways and staircases of buildings housing a number of factories is reported to be particularly bad, and owners of such buildings are lax in making proper arrangements for regular attention to these matters.

In certain industries, particularly those with special fire or explosion risks, the importance of scrupulous cleanliness as a factor in accident prevention can hardly be exaggerated and the close connection between cleanliness of workrooms and dust extraction is obvious.

The problem of how to keep a factory clean extends from factory planning and plant design down to small details of domestic organization and "housekeeping". Moving management and workpeople to a new building does not automatically start a new tradition and the new factory can only too quickly become a "slum" factory. Indeed, cleanliness is very largely a matter of tradition, and difficulties inherent in the building and machinery can be overcome by determined effort. This is often the most noticeable feature when old premises are taken over by an old-established firm with a good tradition, or by a new firm with a progressive policy.

As in previous years, the shortage and high cost of labour for cleaning, in which process workers take less and less part, and the rising prices of materials for cleaning and decoration, are serious barriers to improvement, particularly in smaller factories. Limewash is steadily giving way to emulsion paints for walls and ceilings, and where the surface is smooth, walls so decorated are easy to keep clean by washing.

Probably the statutory requirement most difficult to fulfil is the daily removal of dirt and refuse from floors and benches. Unless supervision is strict, tools, etc., tend to accumulate on and under benches and the dust and dirt build up around them and remain undisturbed, a potential health hazard. Small engineering works and garages are often found to be culprits in this respect. That this need not be so was shown by a busy little country garage. Tools were neatly housed and the workbenches were clear and available for work without having to scuffle a clear space on which to lay the job in hand. The premises were cheerful and warm and when the fresh, clean appearance of the concrete floor was mentioned, the occupier said it had been laid twenty-eight years ago. It had been kept in pristine condition by scrupulous cleaning and the immediate mopping up of any dropped oil. At other garages, steam floor-scraping units are used with good results.

Many firms now use various proprietary compounds for cleaning oily floors, but if there are not adequate drainage facilities to enable the compound to be properly washed off afterwards, the floors are left in a slippery and dangerous condition. This was the experience of a small engineering firm, and better results were subsequently achieved with a wire scraper.

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Inspectors remark that there does not seem to have been the considerable increase which might have been anticipated in the use of labour-saving devices such as floor-cleaning machines. These were most commonly installed in factories which already had a high standard of cleanliness. In one large works, a scrubbing machine is driven up and down the gangways all day. The driver, who is aged 70, has only to keep the supply tanks full of water, detergent and disinfectant.

The use of vacuum cleaning plants of all types for the removal of dust and fluff from walls, girders and plant is steadily increasing. A retrograde step has been taken in some textile factories, the occupiers having converted the machines to blow the dust from the surfaces. They said that even the large machines were not sufficiently powerful to remove large quantities of dust and fluff. Recent developments in the provision of local exhaust at carding machines, etc., will, it is hoped, help to eliminate this problem of collecting excessive dust.

Firms are adopting various schemes to combat the shortage of labour for cleaning. The employment of older persons, possibly the firms' pensioners, is proving very satisfactory in various industries. They may be employed during normal working hours, or in the evenings. They clean at their own pace and have the patience to do the work methodically and more satisfactorily than the youngest junior, to whom, in the less well-run small factory, the job is often given. Older men are employed in some tailoring factories, on part-time evening work, in collecting cloth cuttings and in cleaning workrooms. Some firms employ their adult male workers to clean on Sundays, on a rota system by which each man works every fourth Sunday. Contractors may be engaged to do routine cleaning as distinct from decorating. At a large bakery, cleaners employed by a firm of contractors work from 6 a.m. to 12 noon with a ten-minute break. They scrub floors and do general cleaning.

The outstanding need in relation to cleanliness is to have proper organization. Arrangements to facilitate the work are commonly found, not only in building design, e.g., by the provision of safe means of access for the cleaning of windows, roof lights and high fixtures, but in matters of housekeeping. Oil-trays are a commonplace under textile machinery; trays for catching scraps of material are found under sewing machine benches, loose gear is more frequently placed on boards or otherwise housed, instead of being left on the floor. Improved splash guards on machines and better methods of lubrication are also helping to keep workshop floors in a more satisfactory condition. Better lighting has, of course, had a good effect in showing up deficiencies.

On the whole, factory workers seem still to be less concerned about cleanliness than about heating and ventilation. The appearance of a factory may largely depend on the discipline exerted by the management. The habit of throwing empty cigarette packets, cigarette ends, lunch-papers, fruit-skins and the like, on the floors of messrooms, washrooms, sanitary conveniences, passages and even workrooms, is gradually being eradicated by the ample provision of litter baskets, by supervision and by the example of the tidier workers, who appreciate greater cleanliness. In some Districts, Inspectors find that young people are both tidier and cleaner than their parents, and this promises well for the future. Again, the influence of married women, who are not prepared to put up with bad conditions and who can so easily change their jobs, is said to be improving the standards of cleanliness in factories where they are largely employed. It is often noticed that the dirtiest factory has the highest labour turnover and managements are realizing that a clean

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factory attracts a better type of worker and that improved production follows. The effect of local stimulus has been noted in areas in which new factories have been built and also where transformations in cleanliness have taken place in iron and steel foundries as a result of the implementation of the Special Regulations.

It is generally easier for firms in country areas to keep their factories clean because the air is cleaner, but in one rural industrial estate the use of low-grade fuels and the omission of grit arrestors from the plant had disastrous results in producing air pollution. It is hoped that the impetus given by the Clean Air Act will have the effect that factories as well as other premises will be able to keep a good deal cleaner.

It may be some considerable time before the scrupulous cleanliness found in the best food, drug, etc., producing factories can be attained even by all factories engaged in clean processes, but improvements are being effected in all industries. Possibly the greatest advances have been made in the industries handling dirty and dusty materials from which labour would otherwise tend to drift.

Unsuitable Premises

Sometimes old properties, often in a neglected condition and with damp walls and leaking roofs, are found in use for industrial purposes for which they were not designed. Landlords are unwilling to spend money on essential repairs and the shortage of suitable accommodation forces occupiers to remain under very adverse conditions, pending the completion of clearance and rebuilding schemes. Conditions in a doll-making factory were such that application to a court of summary jurisdiction was successfully made for an order, under Section 40 of the Factories Act, 1937, requiring the cessation of work in the factory. The premises were in a mews and had for the past eight years been under threat of compulsory purchase for demolition. Another toy manufacturer started a factory in a building with 4½ in. brick walls and no rainwater gutter. Naturally the building was very damp. It had been intended for use, with partitions, as lock-up garages. Other damp premises were reported: for example, in a coach-building works during wet weather water seeped through the floor and remained in puddles; in a lampshade factory one wall of a workroom was built into a hillside and was constantly damp. In some factories, the fall pipes from gutters are inside the building, particularly in the case of valley gutters, and heavy rain often causes leaks from these interior pipes and drains. Many occupiers appreciate the electrical risks caused by dampness and dripping water, so that defective roofs, etc., are dealt with in the interests of safety rather than of health. Inspectors have no power under the Factories Act to deal with leaking roofs and the like except by invoking Section 40 of the Factories Act, 1937 (as amended by the Factories Act, 1948).

One Inspector reports that, in his area, cases of structural dampness are found fairly regularly in the course of routine inspection. Occupiers, acting on advice to consult a specialist, have found that surface treatment, usually by a silicone preparation, is effective in curing the trouble. In the case of a bakehouse, in which black discolouration appeared shortly after any redecoration was done, an Inspector recommended the occupier to experiment with a dampness inhibitor. The occupier sought advice from experts, who supplied a suitable preparation. After treatment, redecoration was successfully undertaken. A new laundry having similar trouble with the walls of the messroom was told of the baker's experience at a time when the manager was being rapidly disheartened, and the same technique was used there with equal success.

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Underground Workrooms

The use of underground workrooms is in general decreasing except in very congested areas. It was, therefore, a matter of concern to find in a rebuilt retail shop in the centre of a city, underground rooms, having poor ventilation and inadequate means of escape in case of fire, in which dress alterations, radio and television repairs, etc., were carried out. In another case, a basement of a showroom had been fitted up for intermittent repair work. The firm had failed to notify intention of occupation; the workrooms were totally unsuitable and work, which had included cellulose spraying and welding, was immediately stopped and the plant removed. Another occupier, who had failed to send notice of occupation, was using the basement of a converted dwelling house for film developing and printing. Legal proceedings were taken and a substantial penalty imposed; a certificate of unsuitability was served under Section 53 and was not disputed. In a small underground room barely large enough for five, some eight workers were employed on the grinding of needles. The occupier had started by working on his own and had gradually extended the business. He said he had been looking for new premises, but found it impossible to obtain any. When he understood, however, that a certificate of unsuitability would be issued, his renewed efforts met with success within a matter of weeks. While the most unsuitable of underground workrooms can usually be eliminated, Inspectors consider that until better accommodation is available, there is little hope of real improvement in border-line cases where it is felt that working conditions are certainly less pleasant, if not less healthy, than in rooms above ground with natural lighting and ventilation.

Overcrowding of Workrooms

Overcrowding of workrooms is no longer a serious problem in most areas, though it remains one which requires constant vigilance, particularly in congested urban areas and in the clothing and boot and shoe trades. In one tailoring factory, gross overcrowding was found, and it was thought at first that many employees would have to be discharged. This was, however, avoided by the removal of a number of partitions forming the walls of workrooms and by the rearrangement and spreading out of work. A small metal badge-making firm which two years ago employed five workers was found on revisit to employ nearly forty in its two workrooms. The firm in this case had to find other premises. Out of a sample of 156 factories in a London District, eight were found to be overcrowded; in one bad case there were 34 workers in a room suitable for only 19. At a light engineering works in a country area, three workrooms were found to be overcrowded to the extent of about 40 per cent; bad distribution rather than real lack of space was the cause of the trouble in this instance.

Noise

Though no new techniques for dealing with noise are reported, increasing use is being made of well-tried methods. To reduce the noise at its source is, of course, the best method. This is not often possible, but can be done in some cases. For instance, complaints were made about excessive noise from a drying tunnel containing an air blower, but when a completely new plant was installed and re-sited very little noise was evident. A large brick company experimented with the use of non-metal gear wheels for brick presses. In a foundry, metal "flash" was removed by a tool embodying an electric arc process; this tool produced much less noise than the conventional abrasive wheel. In the same factory, noise made by bar-reeling machines was

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under investigation. The tube works referred to in last year's Report made a thorough-going attack on the problem by getting the National Physical Laboratory to make a noise survey of the entire works. The continuous noise level in various departments ranged from 90 to 102 phons, but in most cases that level was frequently exceeded by transient noises made by tubes falling or being thrown on to the floor. Particular machines such as draw benches, swaging machines, presses and saws were studied and recommendations were made for reducing the noise emitted.

The method of enclosure of individual machines has been applied in certain cases, including a Schuler coining press and a ball-mill. The enclosure of the latter was interlocked with the drive.

The use of insulating mountings for noisy machines such as power presses, newspaper printing machinery and boot and shoe machinery is increasing.

Lining walls and ceilings with sound-absorbent material is also becoming more common, particularly as most sound-absorbent materials contribute substantially to the insulation of the building against heat-loss.

Noise reduction is an inherently difficult problem, and usually all possible methods of attack have to be used: for instance, in a braiding room and in a weaving shed in an asbestos factory, re-siting of machines, individual motor drives and acoustic treatment of the walls and ceilings were all adopted and the combined effect produced marked improvement.

CHAPTER 12

Medical and Nursing Services

Health Records and Statistics

IN NOVEMBER 1955 a survey was made of the extent to which factories had medical and nursing services, and the following Table gives the position in factories employing 50 or more persons.

Medical Practitioners		
Number of factories having arrangements with medical practitioners:		
(a) Whole-time	421	
(b) Part-time, more than 12 hours per week	252	
(c) Part-time, less than 12 hours per week	3,946	
	4,619*	4,613*
Number of factories having no arrangement with medical practitioners		17,080
Number of factories covered by survey		21,693

* Six factories have both a full-time and a part-time Medical Officer.

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Nurses

Number of factories employing nurses:		
(a) Whole-time	4,437	
(b) Part-time only	642	
	5,079	
		5,079
Number of factories not employing nurses		16,614
Number of factories covered by survey		21,693

Other Persons with Nursing Training

Number of factories employing such other persons	4,432
Number of factories not employing such other persons	17,261
Number of factories covered by survey	21,693

As one might expect, the most comprehensive schemes of medical supervision are to be found in the larger factories, particularly in those having some special health hazards. The number of small factories with medical supervision is, however, growing. Here again, one usually finds that there is a specific health risk and in many cases Inspectors have pointed this out and advised the introduction of medical supervision.

For example, at a small factory manufacturing insulating slabs containing about 5 per cent asbestos, the directors were concerned about the health of the workers and were anxious not to employ anyone who might be suffering from tuberculosis. They therefore arranged that a chest specialist should carry out pre-employment and periodical medical examination of all workers.

At a factory preparing clay, etc., for pottery ware, where very few were employed, a similar scheme was started for the workers. In this case, in addition to pneumoconiosis risk there was also a risk from lead poisoning.

Similarly, at a small waste-metal recovery factory in the West Country where there is a potential lead risk, a part-time doctor is employed to carry out monthly examinations, and arrangements have recently been made for blood counts to be taken quarterly by the pathologist at the local hospital.

Originally, the most common reason for setting up medical supervision, both in large and small factories, was the existence of special health hazards, such as the use of lead, cadmium, asbestos, and the large number of materials which might give rise to dermatitis. Certain food and cosmetic factories introduced medical supervision as much to ensure the purity of the product as for the benefit of the workers, and some of the best examples of medical supervision are to be found in this type of factory. However, more and more occupiers are realizing the value of medical supervision in improving the efficiency of factory workers and today many factories with no specific health risk have well-organized schemes.

The scope of medical supervision varies enormously, ranging from periodic visits from a doctor to examine persons subject to a particular risk, to a full-scale scheme which may cover any or all of the following subjects:

1. Supervision of nursing and first aid services, including emergency treatment.

2. Examination of new entrants, often including specially detailed examinations for apprentices.

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3. Periodic medical examination of some or all workers.

4. Examination of workers on return to work after sickness or after absence due to injury.

5. Supervision of the health of young persons and older workers.

6. Medical and minor surgical treatment, usually in consultation with the patient's own doctor.

7. Infra-red and ultra-violet ray treatment, massage, chiropody, ophthalmic and dental treatment.

8. Keeping of sickness records.

In addition to clinical examinations, some factory medical departments arrange for tests such as chest X-rays, blood counts and urine tests, where these would be specially likely to assist in the diagnosis of causes of ill-health or help to identify some particular toxic substance. For example, at a factory where there is an asbestosis risk, X-ray examinations are made of all new employees when they start work. Further X-ray examinations are made annually in departments where there is the greatest risk and of all other workers every two years. Even if the medical officer considers that the X-ray films show nothing abnormal, the patient is given a thorough medical examination. X-ray photographs are also taken of any worker who complains of symptoms that may indicate lung trouble. At other factories, where there is a lead risk, blood tests are made regularly and in some cases urine is examined.

It is usual for all treatment to be given in the firm's time and for dental and ophthalmic services to be arranged under the National Health Service. In an endeavour to reduce the incidence of winter ailments, many firms distribute, without charge, halibut liver oil capsules or vitamin tablets.

The young and older workers are the particular care of the medical departments in many modern factories. Signs of malnutrition are watched for in young workers and at one factory this is related to cases where the home environment is known to be below normal. At a printing works the doctor makes a thorough medical examination of all apprentices before they are indentured. This examination is agreed upon before an apprentice goes before the apprentice advisory committee. Boys are particularly examined for vision, including colour vision. Recently, one apprentice was found to be colour-defective for reds and greens, but this proved advantageous, as his sight was more discerning for the shades of grey between which he had to discriminate when he worked on steel plates. If an apprentice is found to have defective refraction he is immediately sent to an optician.

Older workers are often tempted to carry on their normal work longer than they should in the interests of their health. Medical examination in the case of these workers is directed to extending their working life as long as possible, either by some amelioration of working conditions or by transferring them to more suitable work.

At one factory, where about 10 per cent of the workers are over 50 years of age, the doctor considers 50-60 as the age at which there is most scope for preventive medicine, for diagnosing conditions which may easily lead to incapacity or death and for taking action to prevent aggravation of such conditions. At another factory, the senior medical officer hopes in the near future to arrange for periodic medical examination of all workers of 60 years of age and over and gradually to include those of 59 and under.

Periodic examination of all workers is not common except where special hazards exist, but workers who have certain special responsibilities are

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examined at regular intervals in some works. For instance, at an iron and steel works crane drivers, locomotive drivers and shunters have to pass a medical examination for eyesight, hearing and heart soundness before they are put on to the job and they are re-examined on return to work from illness. Periodic medical examination is shortly to be instituted. In a number of other works it is reported that crane drivers are medically examined regularly to ensure that they are fit for the job.

Comprehensive schemes such as have been described involve the employment of one or more full-time medical officers with a staff of nurses to assist them. The following examples are typical.

At a large motor car works there are four full-time medical officers, including a surgeon who is also a clinical assistant at a local orthopaedic hospital, to which he can refer cases from the factory. In addition to a large staff of nursing sisters and assistant nurses there is a radiologist, physiotherapist, pathologist-technician, and a rehabilitation officer.

At a chocolate works employing about 11,000 persons, there is a full-time works doctor, three part-time doctors, three State Registered nurses, and four assistant nurses. There are also two qualified physiotherapists. A dental clinic at this factory has three full-time dentists for day-attendance and three dentists for attendance during the evening. Dental treatment is a condition of employment for all junior employees. The Inspector reporting on this factory states, "The success of the medical work here has been built upon the basis of close co-operation with local doctors. On a short-term basis, sick absence can be reduced by proper treatment readily available; as an obvious example, physiotherapy and electrical treatment at the factory cut out loss of time incurred in attending hospital. But in this factory the long-term view is taken of the value of good health to the individual: the factory has a swimming bath and every boy and girl is taught to swim; remedial gymnastics are arranged for postural defects; convalescence is arranged where required and the medical department is responsible for a safe and healthy working environment as well as for the various kinds of treatment."

It is usual where there are full-time works medical officers for them to spend a good deal of time studying the processes, in consultation with engineers and chemists, and they also advise occupiers how best to improve environmental conditions. It would appear, however, that few part-time medical officers pay much attention to general environmental conditions. It may be that the special health hazards keep them fully occupied, but it is clear that to widen their sphere of action on these lines would be of advantage to the health and efficiency of the workers. It must, however, be admitted that in some cases the management is the real culprit in not realizing that the doctors have an important part to play in studying the general environmental conditions.

At works with the less comprehensive schemes, part-time doctors are employed. In some cases these are general practitioners giving part of their time to industrial work, while in others they spend most of their time on industrial work, visiting a number of factories. It is clear that in general the part-time doctor cannot be so expert in industrial medicine and one finds cases where he spends little time outside the surgery. His work there in examining and treating employees is, of course, extremely important, but it cannot be so valuable as if he were conversant with the work actually being carried on.

Many part-time medical officers are also Appointed Factory Doctors, who have an interest in industrial medicine and are in constant touch with H.M.

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Medical Inspectors of Factories. The success of this arrangement is reported from a number of Districts, the following being typical. One Appointed Factory Doctor, hearing that an engineering factory was now using cyanide, arranged to visit and see the process, which incidentally was done in what must be one of the cleanest hardening shops in the country. This particular firm had been advised by the suppliers of the plant and the cyanide to obtain the equipment and materials (sodium nitrite and sodium thio-sulphate) for intravenous injections to be used in a case of cyanide poisoning. The doctor's visit was therefore useful in that he learned where and how this equipment was kept and was able to explain that the injections should only be given by a doctor.*

Where there is a medical officer, either whole-time or part-time, the nurse, as in all medical work, is an invaluable assistant. One finds, however, in the small factory, nurses working alone with only infrequent contact with a medical officer.

Many Inspectors give examples of the efficient work done by nurses, and one example of the effect the nurse has is worth quoting. In a cigar factory a State Registered nurse was appointed for the first time about a year ago. The works manager said that at first he considered that she was sending far too many people home and was consequently causing the firm much loss of production. During the year, however, he gradually changed his views and he now thought that by treating people for minor ailments she had kept them at work when they might otherwise have been absent, and that by sending home people suffering from colds during the most infectious stage she had prevented the spread of infection.

Preventing the occurrence of sepsis following accidents involving skin injury is, of course, an important aim of the industrial nurse. It is noteworthy that, despite an increase in the total number of accidents reported during 1955, there was a reduction in the number of sepsis cases from 11,457 in 1954 to 10,751 in 1955, a significant reduction, and one for which the industrial nurse must certainly be given part of the credit.

Broadly speaking, the above comments relate to the large and medium-sized factory. To obtain satisfactory medical supervision in small factories is a more difficult problem. Even the cost of a nurse is often regarded as too high and economy in the use of medical and nursing personnel must be considered. The obvious way is, of course, to have group schemes covering a number of small factories, but it would appear that to achieve this it is necessary to have some central organization prepared to find the money required to launch the scheme. There are, of course, groups of small factories owned by the same firm which have one medical service covering all the factories, and some of the nationalised industries and a few large industrial organizations have a national scheme of medical supervision covering all workers in the organization, usually in charge of a senior medical officer. The cost of setting up a group scheme is, however, high, and a regular contribution for maintenance is required from all units. This presents some difficulty when a considerable number of different occupiers are involved. There are, however, in various parts of the country, groups of small factories where a group scheme of medical supervision would be of great value, and it is hoped that the surveys which are now being undertaken at the request of the Industrial Health Advisory Committee will point the way to a solution of the problem. In this connection, it is interesting to note that at Southampton the local Advisory Committee on Occupational Health, in conjunction

* Treatment which can safely be given by first aid attendants in cases of cyanide poisoning is described in a cautionary placard (Form 385) obtainable from H.M. Stationery Office.

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with the Southampton Chamber of Commerce and with the assistance of the British Medical Association, have appointed a sub-committee to consider instituting a scheme for medical supervision at the smaller industrial premises, not necessarily limited to those covered by the Factories Acts. They have collected information from other parts of the country where Industrial Health Services are being successfully operated, and are examining the possibility of organizing one in Southampton.

In one or two areas there are group schemes of limited medical supervision run by shipbuilders and one finds similar facilities in the docks up and down the country. They are, however, far less comprehensive than the schemes usually found in factories and deal in the main with accidents.

The two most satisfactory group schemes of medical supervision are to be found on trading estates at Slough and Harlow. Although organized on slightly different lines, they are both doing excellent work and will clearly provide a basis on which other schemes can be developed. Both schemes were started with grants from the Nuffield Foundation, but it is hoped that in time subscriptions from member firms will enable them to be self-supporting.

The Slough scheme, which covers some 300 factories, 200 of which are on the trading estate, was instituted in 1947. The objects were to promote the health and welfare of industrial workers and to show how a service of this type could become part of the general health scheme of the country. The organization includes a polyclinic, two dressing stations, the medical departments of six of the larger firms, a mobile dressing station, and a residential rehabilitation centre. In addition, arrangements are made with a local hospital for X-ray and other facilities. The services offered by the scheme are an emergency casualty service (including medical examination and continued treatment), an occupational hygiene service, a rehabilitation service, and a social welfare service.

Cases of accidents which cannot be dealt with by the factory first aid workers are referred to the central clinic or to a dressing station, where attention by a State Registered nurse and the services of a medical officer can be obtained. All dressing stations and medical departments of member firms are visited daily by a medical officer.

Medical examinations are carried out as required by firms, and where the factory is some distance from the clinic, the mobile dressing station is used. A number of firms require pre-employment medical examination as an aid to the placing of workers. Classes are arranged for the training of first aid workers, and State Registered nurses visit works regularly to check the contents of the first aid boxes.

The occupational hygiene team consists of a doctor, an engineer and a chemist. It advises member firms on the safe use of dangerous materials, such as lead, benzene, chromic acid, etc., and also on the improvement of environmental conditions. A laboratory is available at the London School of Hygiene and Tropical Medicine. The residential rehabilitation centre works in close liaison with the industrial rehabilitation units of this Ministry. The social service department maintains close co-operation with local medical practitioners, local hospitals and all organizations which can offer services to employees.

The joint scheme at Harlow New Town is of later development and commenced operations on November 1st, 1955. At that time there were some 50 factories on the estate, but this number will increase rapidly. The organization of this scheme differs from that at Slough in that it is the intention, if

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possible, to run without a whole-time industrial medical officer. It is hoped to build the scheme around the general practitioners, with a senior visiting medical officer who is, at present, the Appointed Factory Doctor. Member firms who already had a works medical officer will continue with him for normal visits, but will have the services of other doctors when he is off duty. A doctor will be available for any factory at any time in case of emergency, but each factory will receive a routine visit once each week from the doctor allocated to it. The two nursing sisters attached to the scheme visit each factory daily. They deal with dressings, check contents of first aid boxes, and co-operate with nurses and first aid workers. Courses for first aid workers are arranged regularly and a special week-end course on industrial medicine has been held for the local practitioners.

At present the services offered are emergency casualty services (including medical examinations and continued treatment) and a social welfare service. In many respects these services are similar to those offered at Slough. There is a well-equipped health centre at which examinations can be made and treatment given if the factory has no suitable facilities. Eventually, there will be a centrally situated hospital at Harlow, at which X-ray examinations and pathological tests can be carried out. Harlow does not offer a rehabilitation or occupational hygiene service.

This scheme, although less ambitious than the one at Slough, was designed to fit the particular conditions of Harlow and clearly offers a satisfactory industrial health service. It may well serve as a pattern for any scheme intended to cover factories in a limited area occupied by different firms. The great stumbling block is the initial cost, and if this could be overcome there is no reason why many schemes should not be instituted.

Health Records and Statistics

The irreducible minimum of health records in factories consists of those required by statute, namely the Industrial Injuries Act Accident Book, the General Register prescribed by Section 116 of the Factories Act, 1937, and Health Registers required under Codes of Special Regulations, if applicable. From the basic ideas embodied in these indispensable records, many firms have evolved record systems, more or less elaborate, according to their individual requirements.

Firms which attempt more than the statutory minimum keep, almost without exception, a record of attendances at the first aid station or ambulance room. In the simplest organizations the Industrial Injuries Accident Book serves for this purpose as well as for its statutory purpose of giving notice of an "industrial injury" to the employer. The first aid attendant usually makes a note when a patient has been sent to hospital or advised to see his own doctor, and no more is done unless or until the injured person is disabled for more than three days from earning full wages at his usual employment, when the accident becomes notifiable to H.M. Inspector of Factories, and the injured person is usually in a position to claim industrial injury benefit from the Ministry of Pensions and National Insurance. The prescribed particulars as to the accident (including the duration of disablement) are then required to be entered in the General Register.

Firms possessing a trained first aid attendant usually keep a special book, other than the Industrial Injuries Accident Book, for recording first aid attendances, giving particulars not only of accidents but of the illnesses and complaints treated, the treatment given, particulars of any further action taken being also recorded.

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The higher the professional status of the ambulance room staff, the more detailed and exact the diagnosis and record, and the more elaborate the treatment which can be given. Attendance for redressings, etc., is encouraged and similarly recorded, and due note taken of the response of the various cases to treatment. Note is also made of the incidence of various kinds of complaints and mishaps, as this will assist in preventive work. In one large firm, each surgery and first aid room not only makes a periodical return of all cases of accident or illness treated, but classifies these according to the 26 departments of the firm and according to 13 morbidity categories, which are based upon the International Code of Diseases, Injuries and Causes of Death. This Code, published by the World Health Organization in 1948, is that used by the Ministry of Pensions and National Insurance in classifying sickness and industrial injury spells; the returns made in the firm are in this respect comparable with the corresponding figures for Great Britain and the various regions. Such intercomparability of statistics has much to recommend it; more will be said of this below.

In addition, an individual health-record card is usually kept by firms which have a pre-employment medical examination. This examination is often very detailed and includes urinary and haematological findings, results of eye tests and assessments of dental condition. Any ascertainable medical history is included, as well as the name and address of the worker's own doctor. Information from the surgery attendance book is transferred to the health record cards. Details of any subsequent medical examinations are, of course, also entered on the card, whether these are routine examinations for all employees (rather a rarity in the absence of special health hazards) or whether they are periodic medical examinations instituted on account of some special risk. Needless to say, these records are supplementary to, and not in lieu of, the statutory records of examinations of young persons or of persons subject to Codes of Special Regulations. A record of sickness or injury absence is kept on or in conjunction with the individual health record card, showing the date and length of absence, the cause, whether treated by own doctor or hospital, whether seen by the surgery staff on return, remarks, and action taken (if any). The individual health record card is thus a *sine qua non* to any comprehensive system of medical supervision, and deserves both careful design according to the needs of the organization, and proper maintenance (with clerical help if necessary). Details of the individual health record cards are always regarded as confidential to the surgery staff, but group records, usually analyses of absence, are compiled from them for managerial consideration.

Absence records are often kept in the form of man-hours lost. For production purposes in any one organization this is the most obviously useful quantity to record and to study from year to year. The man-hours lost are in some cases expressed as a percentage of the total man-hours actually worked, as this is a figure usually in existence in the firm's records, while the maximum possible man-hours is a matter of somewhat arbitrary definition. The former is probably the better procedure, as the international accident frequency rate is given on the basis of man-hours actually worked. The detailed definition of the sickness absence rate for internal purposes in any one organization does not matter very much, so long as the definition is the same from year to year and the persons scrutinizing the records know how the figures are arrived at.

Analyses of sickness absence are usually made into departments, males and females, hourly-paid and other grades, and so on. These may again be analysed into causes of incapacity, and these are again split into sickness

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and injury categories. These sickness absence rates (or maybe merely the figures of man-hours actually lost) are usually tabulated monthly and annually. And there the matter often rests, unless some research-minded person, be he executive, doctor or nurse, begins to look at the accumulated data, to wonder what they mean and what can be done to reduce the totals. In some cases the meaning will be immediately apparent: for instance, in one year a nation-wide influenza epidemic took its toll, or there was a local outbreak of food poisoning; but a satisfactory answer to questions such as whether the rate in one department is significantly higher (or lower) than that of the rest of the organization or whether so many cases of chrome ulceration in a year is or is not significantly different from the annual average will usually require the services of a statistician. If there is one in the organization he can ensure that valuable information is not lost in the personnel records and that, on the other hand, time is not lost in fruitless speculation and misdirected effort.

The next stage in the study of absence records occurs when one organization wants to compare its figures with those of others in the same neighbourhood or industry. Here the difficulty at once arises that, broadly speaking, no two sets of records are compiled on exactly the same basis. For instance, some firms count only sick absence verified by medical certificate, while others include some or all of other spells of alleged sick absence and others again do not differentiate between sick absence and injury absence. Then the definition of the rate varies: while, as above, most firms keep a percentage of man-hours lost (which is in effect a severity rate) others keep instead, or in addition, a frequency rate such as the total number of separate absences per average total number of persons employed. Further complications occur, as some rates do not differentiate between males and females and between manual and non-manual staff, or between whole-time and part-time workers and so on. A generally accepted standard method of defining sick absence and of computing absence rates is essential to any inter-organization comparisons. The British Institute of Management and the Institute of Personnel Management are now working on such a standard and it is hoped that one will be evolved which will command general acceptance and which will also facilitate comparison with the national figures published in the Annual Reports of the Ministry of Pensions and National Insurance.

One point worth mentioning is that sick absence figures, particularly in a small organization, can be very much distorted by the occurrence of a few cases of very long illness, if the total man-hours lost is the only quantity recorded. It is true that this is the most useful quantity to study from the production manager's point of view. A less misleading quantity, from the point of view of preventive medicine, is the quantity used by the Ministry of Pensions and National Insurance, namely the "median duration" of absence, that is to say, the length of absence after which half the cases return to work. The use of the median duration also avoids the need for artificial "weighting" of the figures in cases of death or of permanent partial or total disablement, whether due to illness or accident.

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CHAPTER 13

Temperature and Ventilation

Temperature

Under normal conditions, the compliance with the requirements of the Factories Act, 1937, as to the maintenance of a reasonable temperature, both as regards the upper and lower limits, is fairly good, but the year 1955 imposed an unusually severe test in both directions, as an exceptionally cold spell in the early part of the year was followed by an exceptionally warm summer. The cold spell revealed unsuspected weaknesses in many heating systems which had proved quite adequate in normal winters, while the warm spell, which focussed attention on ventilation, showed up numerous deficiencies. There was thus an increase in the number of complaints, both of too high and too low temperatures, although this increase was much less than might have been expected in view of the abnormal weather conditions. Several Inspectors attributed this reluctance to complain to a general improvement in industrial relations and to the fact that most firms made a genuine attempt to improve unsatisfactory conditions. The employees appeared to be quite willing to put up with a certain amount of temporary discomfort where the works relations were good, but, on the other hand, complaints were sometimes received of conditions which hardly seemed bad enough to justify an official complaint, and in these cases it was often found that relations between management and employees were somewhat strained.

The increasing use of insulation in the structure of buildings, which has been mentioned in previous Reports, continued during the year, but several cases were reported of new buildings of very poor construction, which had already caused considerable trouble. As with other aspects of heating and ventilation, the best time to consider the insulation of the building is, of course, during the planning stage.

In many large shops, the loss of heat through large doorways continued to cause much unnecessary discomfort, in addition to costly wastage of fuel. Successful methods of dealing with this problem included the installation of automatically controlled power-operated doors, of personnel doors (which may either be inset in or placed adjacent to the main doors) or of self-closing rubber doors, the provision of air-locks or of hot-air curtains, and the general use of radiant heating.

Another useful contribution towards fuel economy, particularly in sawmills and joinery works, was a further increase in the burning of waste products to produce heat, in some cases by firing boilers and in others by the use of sawdust-burning slow-combustion stoves. In addition, several more cases were reported in which slow-combustion stoves had been converted to permit of the burning of waste oil such as sump oil from motor cars. The tendency to instal oil-burning appliances continued and in most cases where a change took place, it resulted in a more efficient and economic heating system and in better conditions in the workroom. The use of open coke braziers decreased steadily and in most cases where it was discovered, the braziers had been introduced surreptitiously by the workmen, in spite of orders from the management prohibiting their use.

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There is need for specially good general ventilation in connection with some types of heating appliances, where the products of combustion are discharged into the air of the workroom. A typical case is a stove, designed to burn sump oil, which a firm engaged in the repair of heavy vehicles plan to import and which, subject to a satisfactory trial in their own factory, they propose to market in this country, where it should prove attractive as a cheap means of heating garages. Although paraffin-burning convection heaters have been greatly improved in design in recent years and, being easy to obtain and instal, are serving a useful purpose in small factories, both this type of heater and the free-standing gas radiator call for a good standard of general ventilation if stuffiness is to be avoided. The experience of one firm, occupying a single-storey brick building comprising one large workroom and offices, is of interest. The unglazed areas of the north-light roof of the workroom were lined with insulating-board. There was good natural ventilation. When the factory was built, 18 unventilated unit-type gas heaters had been installed, at a height of approximately 9 ft. above floor level. During the winter of 1954/55, there was a marked increase in sickness among the persons employed in the workroom and it was thought that this might be due in part to the use of the unventilated gas heaters. On medical advice, it was decided to discontinue the use of the gas heaters and, during the summer, 22 thermal storage electric heaters were installed. When they were put into operation a careful check was kept. Room temperatures were taken and recorded three times each day. It was found that, during the coldest days, temperatures above 56°F. could not be attained. Pending the provision of additional electric heaters of the same type, six of the gas unit-heaters were again taken into use in order to raise the room temperature to at least 60°F. at 8 a.m.

Reference has been made in previous years to these electrically-heated thermal storage units which are heated up during " off-peak " periods, and the use of these is increasing. One interesting adaptation of this method appeared to be gaining in popularity, namely, the use of concrete as a storage medium, either in the form of a concrete floor or of specially constructed concrete blocks. Radiant heaters of various types were also increasingly employed and were successful in the heating of large, sparsely occupied workshops such as hangars, and also of partly open workplaces such as some sawmills and structural engineering works.

Cases of excessive temperature noted considerably outnumbered those relating to low temperature. The complex nature of the problem is well illustrated by the wide range of factories or processes in which unsatisfactory conditions had to be remedied, e.g., glass works, laundries, foundries, heat-treatment shops, bakehouses, rubber works, textile mills, forges, tyre-moulding, wool-combing, etc. Generally, conditions were greatly improved by the application of one or more of the following remedies: improved design of plant; better insulation to reduce loss of heat; better spacing and layout of plant; better construction and insulation of buildings so as to improve conditions both in summer and winter; better ventilation, including the installation of fans to provide local air-movement, and the provision of screens to shield workers from radiant heat. As in previous years, examples were quoted of conditions which had formerly been fairly satisfactory becoming decidedly too hot during the summer owing to a changeover from line shafting to individual drives, the cause of the trouble being the heat dissipated by the large number of electric motors and the absence of air movement formerly caused by the shafting and belts and pulleys.

Cases of low temperature occurred because the heating systems for a variety of reasons proved inadequate, although the construction of the building

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was often a contributory factor. In some cases the heating equipment had been badly installed. For example, in one works the electric unit-heaters had been wired-up in groups of six, thus when a fault occurred on one unit all six had to be put out of action, leaving a considerable part of the works unheated until the fault had been repaired. The system was subsequently re-wired to enable each unit to be independently isolated. In many other cases, the equipment had initially been quite satisfactory but had subsequently deteriorated owing to lack of maintenance. A typical example of this occurred in a small works which was heated by steam pipes and radiators fed from a medium-sized hot-water boiler situated in a corner of the main assembly shop. This boiler had been in use for some years and the sudden freeze at the beginning of the cold spell was rather too much for some of the joints. The occupier did what he could to mitigate conditions by purchasing portable oil-stoves and electric fires, but these were not capable of raising the temperature to a reasonable minimum. By the time the boiler could be repaired, the cold spell had ended. It is often not appreciated that over the passage of years installations such as heating systems depreciate with normal use and that final breakdown is often sudden and disastrous. In the type of factory where such breakdowns occur there is usually very little preventive maintenance.

One development worthy of mention, which could have far-reaching effects, was the production of a small heat pump which, by means of an ingenious reversing valve, can be used for heating in winter and for cooling in summer.

Another valuable development was the design of a modified type of reverberatory furnace for use in non-ferrous foundries, which will replace many of the old open bale-out type of furnace. This new furnace, which was developed by a member of the Joint Standing Committee on Non-Ferrous Foundries, following investigations by the Technical Sub-Committee into the causes of excessive heat, has a much higher efficiency, partly as a result of greatly improved insulation. Comparatively little heat is dissipated into the workroom; in fact, in a foundry where several of these furnaces have been installed, additional means of space heating are now required during the winter.

General Ventilation

The abnormally warm summer revealed the inadequacy of a number of ventilating systems which, although suitable for normal conditions, were failing to cope with the additional load placed upon them by the unusual conditions. In most cases, the deficiencies were remedied without any great difficulty. It was frequently found that the ventilation could be greatly improved by making full and proper use of existing facilities, e.g., by opening more windows or roof-lights, which in some cases had not been opened for years. Frequently, however, it was necessary to provide additional openings, supplemented by mechanical means of ventilation. The importance of having adequate and properly designed air-inlets as well as air-outlets, and also of ensuring suitable air-movement, is often overlooked. Inspectors reported that, when there were numerous fans extracting air from a room, it was only when doors were difficult to open that it was realized that the air was trying to enter in that way.

During visits paid to check temperature and humidity in cotton weaving sheds, it was found that conditions were quite comfortable even when the hygrometers showed a dry-bulb reading of 80°F., or over, provided that the ventilation gave adequate air-movement.

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It is unfortunate that there is no instrument by which the adequacy of the general ventilation of a workroom can be readily and accurately measured. Subjective judgments are obviously unreliable. Really bad conditions cannot fail to be noticed, but such conditions are rare, while between the obviously badly-ventilated workroom and the really well-ventilated one lie many places where there is room for improvement but where it is not easy to form an accurate judgment and even less easy to convince the firm that improvement is necessary. Difficulty is often experienced in securing the co-operation of workers in an effort to improve general ventilation; Inspectors have found fans which no one had troubled to switch-on, complete plenum systems disused and ventilator openings blocked up. In some cases, it was only the long spell of hot weather which made conditions bad enough to bring employees to the point of complaining about lack of ventilation, which they had not hitherto noticed. For example, women working on the top floor of a warehouse were dissatisfied with the conditions; it was found that there were a number of roof-lights, capable of being opened but which were not in use and that others were in a dilapidated state and required repair before they could be used. There was no means of natural ventilation at low level; a number of windows along each wall had not been opened for years. The atmosphere of the workroom was definitely stale.

Windows are often kept shut because workers, quite naturally, dislike draughts. In the closing-room of a shoe factory, having the type of window which swings inwards and outwards on a horizontal axis through the centre, the hopper method of solving this problem was successfully adopted. Hoppers fitted on the insides of the windows now direct the incoming air upwards instead of on to the workpeople and also make the flow of air much more gentle than before.

Among air-conditioning plants installed during the year was one at a rayon weaving factory, where the circulation of the washed and filtered air produced a most noticeable improvement. Conditions in the crêping department, where the temperatures varied from 78° to 81°F. on a day when the outside temperature was 74°F., compared very favourably with the naturally-ventilated crêping department of another factory in which the temperature was 94°F. when the outside temperature was 78°F.

The following summaries cover some of the cases dealt with during the year in one District alone. Additional extraction and circulating fans were provided in the pressing and ironing rooms of several dry-cleaning works and in the pressing departments of several clothing factories; this resulted in a great improvement in working conditions. In a small cotton weaving shed the addition of several extraction fans, supplemented by portable propellor fans, proved successful. In a large cotton weaving shed, after several attempts to remedy conditions by patchwork methods had failed, a complete air-conditioning plant was eventually installed. A full air-conditioning installation in a rayon weaving shed was primarily intended to assist production, but the workers benefited to a very considerable degree from the improved conditions. An installation of full air-conditioning plant in the fermentation room of a large brewery had as its main object the maintenance of optimum conditions while preventing the accumulation of excessive quantities of carbon dioxide.

There has been a welcome increase in the number of cases in which architects and occupiers have consulted the Department during the early stages of the planning of a new building. The advantages of this to everybody concerned should be obvious and have been stressed more than once in these Reports. There are, however, still too many instances of buildings being

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erected without any such preliminary consultation and with little or no thought having been given to the requirements of the Factories Acts with respect to heating and ventilation. Such cases cause much unnecessary trouble and the subsequent alterations and additions invariably involve the firms in expenditure greatly in excess of that which would have been incurred by the inclusion of adequate arrangements in the original plans. The following are two instances in which ventilation schemes designed for particular processes failed to fulfil their function. In a new building containing impregnating plant, several large ventilators, provided with cowls, were fitted along the roof-ridge. The architect had anticipated that the heat of the drying-ovens would provide sufficient thermal movement to keep the atmosphere fresh. Experience proved that this "natural" ventilation was quite inadequate. During calm, humid weather it became impossible to work in the shop. A remedy was found by fitting exhaust fans in the ventilators. Another factory had been reconstructed to house cloth-finishing machines; numerous extraction fans had been installed near the ridges of the north-light roof and ample air-inlets, some mechanically assisted, were available. These arrangements were not sufficient to deal with the heat from the drying-chambers nor to remove fume from the process plant. Conditions were remedied by further enclosure of the machines and by the installation of additional exhaust fans to draw air from the workroom at a lower level.

Reports from the Manchester area referred to the great improvement in atmospheric conditions which had resulted from the "smokeless zone". This has considerably eased the general ventilation problems in many factories, as much greater use can now be made of ordinary natural ventilation facilities such as windows and roof-lights, which formerly were never opened because of the large quantity of soot and other impurities which was thereby admitted to the workrooms.

Ventilation is closely bound up with other environmental factors, such as temperature and humidity, and further reference to improvements in general ventilation is made under these headings.

Humidity

Conditions in factories employing artificial humidification to facilitate the process are reported to be generally satisfactory. In spite of the abnormally warm summer, very few cases were recorded where work had to stop, as required by the Cotton Cloth Factories Regulations, on account of excessive wet bulb temperatures. The reason for this generally high standard is undoubtedly because the amount of humidification permitted is strictly controlled by legislation.

Most of the trouble due to excessive humidity arises in factories where this is produced as a "by-product" of the process, e.g., in paper mills, bleaching and dyeing works, laundries, pressing departments of clothing factories, sugar-beet factories, canneries, confectionery works and so on. Even if this problem cannot be completely solved, conditions can be greatly improved if tackled in a systematic manner, e.g., by applying one or more of the following principles: (a) total enclosure of plant; (b) partial enclosure plus exhaust ventilation of plant; and (c) improved general ventilation, including the injection of warm air where necessary. In many cases, the lack of success which has been reported was clearly due to a premature admission of defeat after the failure of an initial effort which was based merely on half-measures.

Several new and extensive installations of automatic air conditioning plant have been reported in factories which were already employing artificial humidification. The new plant should normally give a much closer control over the conditions in the workrooms.

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Some increase in the use of artificial humidification has been reported in the worsted section of the woollen industry and in parts of a large nylon spinning factory. It will also be employed in some departments of a new viscose rayon yarn factory now under construction.

Local Exhaust Ventilation

Apart from isolated cases of unsatisfactory conditions, the standard of general ventilation is reasonably good or at least adequate. Unfortunately, the same cannot be said of the prevention of air contamination by means of local exhaust. The volume of complaint relating to unsatisfactory installations in this branch of ventilation was very much greater than in the case of general ventilation. This is probably due to the fact that workpeople are much more conscious of the possible health-hazard due to dust or other air impurity, than of the long-term risk due to poor general ventilation where no specific impurities are present. The problem of the prevention of contamination is never completely solved. New processes are continually being introduced, which create new hazards, while old processes are modified or speeded up, with the same result. There were, however, reports of many improvements in exhaust ventilation arrangements, and most of the cases which were the subject of complaint were eventually dealt with satisfactorily. In some of these cases, the trouble had arisen on the introduction of new processes which the managements had not realized possessed any health-hazard, while in others, alterations or extensions had been made to existing plant which had been originally quite satisfactory, but which proved incapable of coping with the additional load imposed upon it. In this branch of ventilation, where health can often be quickly and seriously affected by a defective or inadequate system, it is most essential that when a new process is introduced steps should be taken to ensure that there is no health-risk due to air contamination and, for the same reason, it is equally essential that existing plant should be maintained in an efficient condition.

"Local exhaust" is essentially only the last resort in the prevention of air contamination. Before falling back on this, several other lines of defence should be tried. The first should always be to consider whether the contaminant can be eliminated by making a change in the process or in the methods of production, or whether it can be replaced by a harmless or at least by a less hazardous substance. If the contaminant is a dust, the possibility of employing wet methods should be considered. If neither of these two lines of defence can be used the next step should be to consider whether the source of contamination can be completely enclosed so that the contaminant cannot escape into the general atmosphere of the workroom. Failing this, resort must be had to the application of an exhaust draught, but the source of the contaminant, whether it be dust, gas, vapour, etc., should always be enclosed as far as possible, as this greatly simplifies the problem and reduces the amount of exhaust required. Thus, the next step would be to provide partial enclosure plus exhaust, and, finally, where little or no enclosure is practicable, to resort to local exhaust by means of hoods and ducts.

The problem is by no means solved even when the contaminant has been successfully trapped; there still remains the question of its ultimate disposal. Several complaints were received during the year from factories, and sometimes from private dwellings, of dust or fume being blown from a particular factory into the outside air, without any regard to the possibility of nuisance or even of danger, to the occupants of neighbouring buildings.

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Change in process or alteration in methods of production

The following examples of the elimination or reduction of air-contamination, either by a change in the process or by an alteration in the methods of production, may be quoted.

In the de-scaling of wire the use of hydrochloric acid results in the production of dense and highly objectionable fumes. A well-known firm gave a great deal of thought to this problem, and research showed that it was possible to use sulphuric acid instead of hydrochloric, although the former had hitherto been considered much too corrosive in its action. In addition to eliminating the use of hydrochloric acid, the firm, by the end of the year, had nearly completed a new cleaning house in which large volumes of air are directed across the surfaces of the vats by means of fish-tail blowers and the contaminated air is collected at the opposite side of the vats by ingeniously designed cowls. The acid fumes are then removed by a scrubber.

At a tube works, acid fumes from the pickling boshes were proving offensive to workers and particularly to overhead-crane drivers. The firm obtained a foaming agent to put on the surface of the acid in the boshes and inhibit the rise of fume. As a result, working conditions were considerably improved.

Flux used in tinning operations at a tinplate works had been slightly changed in character and occasionally, particularly during cold weather, fume was given off and the tinmen complained. The firm reverted to the original type of flux.

An example of a change in process, which not only rendered the provision of exhaust ventilation unnecessary but also improved production, came from the cutlery trade. A small firm of scalpel makers performed scalpel dollying on textile dollies dressed with fat and treated with "compo". No exhaust system was provided for this operation and the firm was asked to instal one. As they anticipated leaving the premises, they were most reluctant to proceed; they carried out experiments, however, which proved that the same job could be done on leather-headed wheels dressed with a special "compo". In addition to dispensing with the need for dust extraction, the new method was found to improve production.

An example of working methods being so modified as to remove the men from the contaminant took place in a gasworks where a newly-built retort house was unsatisfactory as regards ventilation. The provision of exhaust ventilation over the retort mouthpiece was considered and the natural ventilation was improved by installing additional inlets at low level. A system of working the conveyor by remote control was then devised in which the level of the coal in the hoppers was automatically indicated by means of warning lights (operated by carbon electrodes). This made it unnecessary for men to work regularly on the conveyor platforms, the position in which they had been exposed to fumes.

Total Enclosure

Examples of the satisfactory results of total enclosure of the source of the contaminant were found in various industries including dyeing, dry cleaning and brickworks. The problem of the removal of excess steam from dyehouses was mentioned in last year's Report. Remarkable success has been achieved in more than one area. All the dye vessels in one textile dyehouse were enclosed during the year. Before this was done it had been, at times,

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impossible to see more than a few feet across the dyehouse because of dense clouds of vapour which formed in spite of hot air being blown into the dyehouse by elaborate ventilating equipment. After the vessels were enclosed, the dyehouse became warm and dry, the need for an elaborate system of general ventilation ceased and the department showed a saving of 25 per cent in its coal bill. In another Division, the amount of steam escaping into the general atmosphere of a dyehouse was greatly reduced by the enclosure of all the dye vessels; it was reported that the atmosphere could now be kept perfectly clear by means of exhaust fans in the roof and by the injection of warm air at a low level when necessary.

The control of dust in brickworks is still a major problem, but the old open screens at one brickworks were replaced by vibro-screens which can be completely enclosed; at a pipe works some progress has been made in enclosing elevators; further experiments are to be made by enclosing the mill and maintaining it under a slight negative pressure, the exhaust being discharged to the outside air. Another brickworks has two large mills for grinding colliery shale and rock, which is a very dusty process. Here also, attempts were being made to provide adequate enclosure and exhaust arrangements.

The following report illustrates the value of co-operation between the management and the Factory Inspectorate. A firm of soap manufacturers were making a scouring powder which had 80 per cent silica content. When the work first began, the operatives at the mixing and filling points were exposed to a concentration of dust which would have been harmful to them. The Medical and District Inspectors persuaded the management to provide respirators and to overhaul and improve their ventilating plant as an interim measure until the firm had completed an extension to the factory, which would be used mainly for the manufacture of this scouring powder. The Inspectors were consulted by the firm at every stage of the development and saw the new plant while it was under construction. The plant, which was designed to be airtight, was nearing completion at the end of 1955. The firm's aim, which seems likely to be achieved, was that no one should be exposed to dust risk.

Enclosure and Exhaust Ventilation

The most common application of this principle, and probably the best known, is found in paint-spraying booths and cabinets. It is probably not generally appreciated how much more widely this principle can be applied. The following extracts from Inspectors' reports are intended to illustrate this point. Again, it should be emphasized that, although total enclosure may be impracticable for one reason or another, e.g., if access to the job is required, the source of the contaminant should always be enclosed as far as possible.

"A firm of fireclay brick manufacturers have been successful in providing a highly efficient exhaust system for the cutting of bricks with a carborundum saw. A cabinet built around the saw is fitted with two exhaust points — one directly behind the saw and the other below. The results are so satisfactory that the inner sides of the cabinet walls are used for 'pin-ups'."

"In a factory making electric dry batteries, mercuric oxide is recovered from kalium cells, and a considerable amount of this compound was found to be present in the air of the workroom. The process was subsequently totally enclosed and provided with exhaust ventilation, and the conditions were thus improved."

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"Ventilation of galvanizing baths was a problem which received much attention, long overdue, at one works. Instead of a normal collecting cowl situated over the hot part of the bath, the whole unit was enclosed in a light structure built of asbestos-cement sheets with wooden supports. These materials were selected because of the effects of corrosion if metal were used. Four fans mounted in vertical outlet ducts effectively removed to the outside air the fumes evolved by the baths."

"Progress in providing localized exhaust for oil fumes is not rapid, but some firms are experimenting. An engineering firm was considerably concerned as to how to deal with oil fumes caused by vaporization of oil due to the heat developed on thread-grinding machines. As an experiment, one of these machines was enclosed and provided with exhaust to extract the fumes. The experiment was successful, and similar arrangements were to be made at the other machines."

"A steel firm, which uses ten swing-grinders in the final dressing of steel bars before despatch, were anxious to improve working conditions. They experimented with an exhaust hood and flexible trunking attached to the machine frame, but this proved to be unsatisfactory. It was then felt that the only effective way of removing most of the dust was to erect a cabinet around the grinder and to arrange for an effective air-sweep past the operator to the wheel and into the cabinet. There are ten cabinets, five back-to-back, each cabinet being provided with 12 in. diameter exhaust-trunking. The open end of each cabinet is 12 sq. ft. in area, and the central air-velocity is 180 ft. per minute."

Hoods and Ducts

Applications of this method are far too common to require much further illustration in this Report. Indeed, one of the main objects of this section is to stress that this method is far too frequently adopted without consideration of any of the other methods, and that even when it is necessarily adopted, it is often misapplied. Many reports confirming this view were received from all over the country, of which the following is a typical example. "Unsatisfactory conditions were observed at two works where scrap brass was melted down and recovered. At one, an oil-fired furnace gave off very troublesome fumes, especially when brass was melted, and the firm obtained the services of a firm of ventilating engineers, who put in cowls and a fan, but this did not improve the ventilation because the fan was hopelessly inadequate."

There are, however, many cases where there is no alternative to this method, but in such cases the hoods should be designed to enclose as far as practicable the source of contamination, or at least be located as close as possible to it.

Diesel Engine Fumes

In several instances, complaints were made of fumes from vehicle Diesel engines. Extensive exhaust ventilation plant was installed to remove exhaust gases direct from vehicles under test, and works Diesel-trucks were replaced by hand-trucks or by electric trucks. In one case, where Diesel trucks were used in the construction of a tunnel, the trouble was cured by the provision of additional booster fans, which improved the ventilation of the tunnel.

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Cotton Card-room Dust

One problem of exhaust ventilation which has been the subject of research and investigation for many years is that concerning the removal of dust from revolving flat carding engines in cotton mills. The British Cotton Industry Research Association have been actively engaged on this work and the Director of Research stated at the Association's Annual General Meeting at the end of 1955 that the age-long problem of dust in card-rooms had been solved. The method devised by the Shirley Institute is essentially one of localized exhaust ventilation applied at the points of emission of the dust from the card. Prototype plant was put into operation in a mill spinning coarse counts and with a high rate of production during 1955; the results are being watched very carefully and samples of the air of the card-room are periodically taken by members of our staff, dust counts being tabulated and assessed. The results obtained are most promising, and it is hoped that it will be possible shortly to recommend this method with confidence to the industry for general adoption.

CHAPTER 14

Lighting and Colour

LIGHTING

THE YEAR was one of steady progress: no unusual developments or techniques were noted. The general standard of both artificial and natural lighting is generally satisfactory, but a few black spots remain, mainly in the older industries, and these seem very black indeed by comparison with up-to-date installations. Inspectors report, however, that resistance to change is gradually giving way, due in part to realization by the management and workers, many of whom have worked the best part of a lifetime under inferior conditions, of the importance of good lighting.

In new factories, as might be expected, the standards of natural and artificial lighting adopted deserve much praise and little criticism. In many large new buildings with excellent provision for natural lighting little or no artificial illumination was required for the work even on a dull winter's afternoon. In smaller new factories, a tendency has been noted to make the workrooms comparatively narrow with, where possible, windows along both sides, so that under average conditions there is sufficient natural light for the process. Several new factories had provided rows of transparent plastic sheeting in the roof of each bay, but it was a pity that in only a few cases was there the foresight to provide catwalks along the roofs to permit easy cleaning.

In the older factories, progress has been steady in the improvement of standards of natural lighting. For example, a large food processing factory replaced an old roof by a new one with north lights, and much pleasanter working conditions resulted. In another instance, one of the first acts of a new company after taking over an old rolling mill was to introduce additional natural lighting by providing extra glazing in the roof.

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In the central districts of some large industrial cities, Inspectors continued to report on the failure of occupiers to keep their windows clean and so to obtain as much natural light as possible. The fact that Section 5 of the Factories Act, 1937, requires occupiers to keep windows clean, both inside and outside, does not appear to be generally understood. The problem of window-cleaning is not always easy to solve, particularly with roof lights, access to which may be hazardous and difficult. Atmospheric pollution in some places is such that the deposits adhere to glass and other transparent materials so firmly that special cleaning techniques become necessary. Occasionally, windows broken by children playing in the street are boarded up and forgotten, until the Inspector points out the matter to the occupier, who has meantime been quite content with the reduced daylight.

It is a matter of experience that workers will readily accept poor natural lighting, although they will complain about artificial lighting. One example was in an old low-roofed building with low side windows. Only in the immediate areas of the windows was there sufficient light to give an appreciable reading on a light-meter. The men working there had made no complaint, accepting this state of affairs as a matter of course.

One insufficiently-appreciated aspect of natural lighting is glare. One Inspector reports that in a large modern factory on a very bright day he passed from a well-lighted shop through a covered passage leading to the open air. The illumination in the passage could not be described as poor, but the sunlight on a light wall at the end of the passage set up a glare which made it impossible to see anything in his path. Two accidents had previously occurred when people had stumbled over objects (which they could not see) in this passage and additional artificial lighting had been installed there, but was not switched on at the time. When it was, the effect of the glare was minimized.

In the field of artificial lighting, standards continued to improve, and Inspectors report, for example, on installations giving 30 lumens per sq. ft. at the working level. In rural areas, a long-standing obstacle to progress, the absence of mains electricity, is gradually disappearing. As the mains reach these districts new lighting is being installed which gives a standard far beyond that attained by many old works generating plants, with their frequent overloads and fluctuating voltages.

A transformation was accomplished in a rope works situated in a very old building and possessing such handicaps as insufficient windows, low ceilings and basement rooms. After purchase by new occupiers, much money was spent in bringing both premises and plant into line with modern standards. Fluorescent lighting proved particularly suitable where low mounting heights were necessary, and the old rope walk in particular has been transformed. Some of the workers remembered the days when the rope walk was a black tunnel, marked at intervals by bat's wing gas burners. Later, bare electric lamps were used. Now, the rope walk is lit uniformly, without glare, by fluorescent tubes in special fittings, and, together with the light-coloured finish on the walls, a truly remarkable transformation has been achieved.

Lighting which is inadequate because of very uneven illumination is still to be found occasionally in some older factories. In a tannery, for example, light-meter readings showed that the illumination varied from 20 lumens per sq. ft. under the lamps to 2 lumens per sq. ft. between the machines.

Glare from badly or totally unscreened bright sources still continued to be a prominent failing. Inspectors report that there still lingers, particularly among workers in the older trades and in the smaller workshops, the prejudice

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that any form of shading for an electric lamp will reduce the amount of light for the work. Complaints have also been received from workers about glare from bare fluorescent tubes, and in these cases the trouble was cured by the provision of suitable louvred screens. It is hoped that by this time all installation engineers are aware that bare fluorescent tubes can give rise to serious glare, and that shades should be provided where necessary.

In a map-making factory, there were several cases of eye-strain, some severe. Careful enquiry revealed that the cartographers were subject to the glare of the overhead fluorescent tubes mirrored in the glass tops of tables and in the polished surface of the plastic material on which minute details were drawn. The surface of the plastic material was, moreover, somewhat wavy so that, as the cartographer altered his line of sight, the bright specular images of the tubes assumed a wriggling motion, which distracted as well as tired the eyes. Alterations were put in hand.

At one large firm engaged in the manufacture of pharmaceutical products it was necessary to ask the firm to screen ultra-violet light tubes to protect the workers' eyes from the radiation.

The need for care in siting plant with glass windows so as to avoid glare and distracting specular reflection is illustrated in connection with the towing hood designed by the British Ceramic Research Association. The operator, when working at this hood, views the work through a horizontal sheet of glass, and a vertical opaque back screen is fitted to prevent glare when facing a window. The hood has, however, been installed in some shops with overhead lighting, either natural or artificial, so that glare and distracting specular reflection were troublesome, and alterations have had to be made, by screening or otherwise. This illustrates the general principle that where workers have to view the work through glass screens, special care must be taken, by suitably placing the lights or otherwise, to prevent these unpleasant effects; if this is not done, the operators are tempted to try to remove or to interfere with the screens.

So far as outside lighting is concerned, the general standard leaves much to be desired and Inspectors express concern over the number of accidents which occurred in outside areas at night and which could be directly ascribed to poor lighting. One Inspector refers to a serious accident to a shunter. The only source of lighting at an important set of points was the suspended light of an overhead travelling crane in a nearby scrap dump. Lighting was satisfactory when the crane was near the points but was most unsatisfactory when it was at the far end of the dump. In another District, a shunter tripped over a points lever. Investigation showed that the men whose business it was to switch on the outdoor lighting had not come to work that shift, so that the outside areas remained in darkness. At a steelworks on a dark night, a bus nearly ran into the side of a locomotive. Immediate improvements included painting the wheels and connecting rods white, and fitting above them bulkhead electric lights on each side of the locomotive, just below footplate level.

An Inspector describes how, on a night visit to a constructional works, four men were found working in a yard, under an overhead travelling crane, moving steel plate, and the standard of lighting was so low that no reading could be obtained on a light-meter. However, progress is being made towards the realization that outside lighting need not necessarily be poor, and some excellent installations of high-level lighting from towers have been noted.

Poor lighting in docks has again caused serious and sometimes fatal accidents. One Inspector reports that a travelling foreman for a firm of

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stevedores was riding round the dock on a bicycle from one ship to another on a dark night in autumn. He is thought to have struck a projecting points lever in the deep shadow of a coaling crane. His body was recovered later from the dock. There is little doubt that the unsatisfactory standard of lighting contributed to this fatality.

Although there has been a marked improvement in lighting in shipyards, difficulty has been encountered in the arrangement of lighting points. The use of light standards, for example, is in places difficult because of the large prefabricated sections handled by the cranes; firms therefore tend to rely on angle fittings on buildings, coupled with lights attached to the cranes which are on rails at the berth side. This arrangement is sometimes unsatisfactory if the crane is at the limit of its travel at the berth side.

Colour

Interest in colour remains unabated, and Inspectors suggest that this represents a continuing reaction against war-time austerity. In some cases it is stimulated by the need to attract workers but in others by the genuine pride of occupiers in their factories. One post-war development in industrial relations is the increase in the amount of "visiting" done between factories, and this has fostered feelings of pride and led to a rapid spread of the use of colour.

Although much has previously been written on the details of colour schemes, it is perhaps worthwhile to mention a few. For example, an Inspector reports that in an electronic instrument factory housed in a five-storey building, the natural lighting from the large windows is excellent and metal venetian blinds are used, as necessary, to prevent excessive glare. The workroom walls are cream and the ceilings Japanese blue. At the main entrance, the walls are crimson and murals thereon depict electrical equations. A firm which manufactures graphite, a substance which escapes all efforts at enclosure and betrays its presence everywhere, determined to improve the conditions, which were not enhanced by somewhat dismal lighting. The work-rooms were "transformed" by a colour scheme consisting of a light blue ceiling, red roof beams and royal blue walls, with dark navy blue near the floors. A fluorescent lighting scheme was installed and the workers commented, "It is now a treat to work at night".

In the case of spacious rooms such as are found in larger factories, an interesting point emerges. The wall decoration, even though well done, may be relatively unimportant. Instances have been noted where the effect of pleasantly coloured walls has been quite lost because of a sea of dingy benches and dirty machines. In such cases, good progress has been made by colouring benches and machines and even the floor.

Outdoor plant does not often receive colour treatment but the tendency to use colour is growing, even on such things as locomotives. In a steelworks, for example, a start was made two years ago by painting one locomotive a bright yellow, to make it more easily visible by night and in conditions of poor visibility. The experiment was a success and now eight locomotives have been so painted; the others will be done as they become due for overhaul. Needless to say, the workers have nicknamed the locomotives "The Yellow Peril", "The Wasp," and so on, but at the same time they have commented enthusiastically about the value of the colour treatment.

The possibility of the formulation of a Safety Colour Code still receives study, on the lines of reduction to the utmost simplicity. At the same time, the use of shapes and patterns, which can be associated with the simple colours, is also being studied, for the purpose of enhancing the signal effect and also of helping those who may have deficient colour vision.

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CHAPTER 15

Industrial Poisoning—Gassing Cases

THE total number of gassing accidents during the year was 255. This number has remained roughly steady since the end of the war. There were, however, only 11 fatalities in 1955 as against an average figure of 21 during the previous eight years; in fact 11 per year is the lowest number of gassing fatalities on record, and I hope that this may indicate something more than the effect of random fluctuation. During the year production has certainly not decreased in the iron, steel, gas and chemical industries, where the chief hazards exist.

Accidents during maintenance work, as usual, took their toll. Instances again occurred of gassing accidents in the open air, when external work was being done on plant, and, as I pointed out in my previous Report, it is erroneous to assume that no risk exists in these circumstances.

The numbers of accidents caused by various gases are given in Table 25.

CARBON MONOXIDE

The total number of cases of poisoning by carbon monoxide reported during the year was 108 (including 7 fatalities), compared with 113 cases (including 14 fatalities) during the previous year.

Blast Furnace Gas

Fifteen of these cases, including two fatalities which occurred in one accident, were due to blast furnace gas. The two men who died were employed at an iron and steel works where blast furnace gas was purified by means of electrostatic precipitators. It was customary for the electricity to be switched off every four hours and for the water sprays to be turned on for about twenty minutes to wash down the dust-collecting plates. The water from the operation went down into the sump from which the excess was pumped out by extraction pumps while the sprays were working. The evidence indicated that the extraction pumps had been allowed to run after the sprays had been turned off, until the water seals had been reduced to a level which allowed the gas to escape. The men, who were informed by the gas control office that the gas pressure was low, turned the extraction pump off and put on one of the filling pumps. Not realizing how low the water level in the sump had become, they climbed to the top platform to turn on the sprays to increase the amount of water entering the sump. By this time a substantial quantity of gas was escaping and this was ignited by a spark from the electrical equipment above the precipitating chambers. When the works fire officer arrived he was informed that two men were missing and after a search both men were found dead on the staging of the precipitators.

Three men were rendered unconscious in a steelworks when a gas torch to be used for drying a ladle, 12 ft. deep and 8 ft. in diameter, which had been relined with firebrick, was placed into position by an overhead crane while two men were still inside the ladle; this was against the works' practice. Owing to the accumulation of foreign matter, the water-seal in the gas pipe was not maintained correctly, nor was the mushroom valve seating properly. Becoming aware of the presence of gas, one of the men was able to escape from the ladle but the other man was overcome. The two other men were overcome when they entered the ladle to assist in the rescue work. The three men were given artificial respiration and oxygen inhalation before removal to hospital, where they recovered.

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TABLE 25

GASSING CASES: ANALYSIS BY NATURE OF GAS OR FUME, 1941-1955

	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Carbon monoxide:															
(*a*) Blast furnace ...	55[5]	41[4]	46[6]	36[5]	37[1]	20[2]	26[2]	21[1]	24[6]	62[16]	20[1]	24[3]	33[11]	13[1]	15[2]
(*b*) Power	65[3]	116[4]	112[6]	111[7]	82[5]	42[6]	36[3]	39[2]	29[4]	22[5]	33[5]	30[1]	22[1]	28[3]	18[1]
(*c*) Coal	38[4]	28[1]	18	21[3]	42[4]	21[1]	25[3]	26[2]	23[3]	11[1]	27[1]	33[3]	34[4]	34[4]	43[3]
(*d*) Other	80[9]	64[3]	55[7]	41[4]	57[8]	34[3]	44[1]	31[3]	25[3]	18[1]	25[2]	21[1]	32[5]	38[7]	32[1]
Carbon dioxide	9[2]	3	—	1	1	1	1	—	3	3	19[1]	8[1]	4[1]	3	—
Sulphuretted hydrogen ...	17[1]	9[2]	12	7	6	4	14[3]	10[1]	11[1]	2	12[2]	9[1]	4	13[3]	5
Sulphur dioxide	16	22	28	9	12	4	8	5	3	6	6	6	15	4	15
Chlorine	43	52[1]	58[1]	59	47	30	22	26[1]	26	25	21	27[1]	36	25	24
Nitrous fumes	217[1]	220[3]	135[4]	55[1]	29	13	10[1]	8	13	5	3	10	11[1]	14	15
Ammonia	13[3]	6	9	8[2]	12[2]	11[1]	11	4	8	10[3]	8[1]	9	11[1]	9	21[1]
Benzol	7[2]	10[4]	1[1]	1	6[1]	5[1]	—	2	1	3[1]	1	2	4	2	7[2]
Naphtha	1	—	—	2	—	—	1	—	—	—	—	—	2	1	—
Petrol and benzine ...	10[2]	2[1]	2[1]	2	1	—	1	1	—	1	—	1	2	3[1]	4[1]
Trichlorethylene	39[2]	18	87[3]	16[1]	14	10	17[2]	12[1]	14[1]	24[3]	6[1]	24[1]	11[1]	19[1]	18
Nickel carbonyl	6	37	30	37	15	14	5	2	7	5	3	10	5	2	1
Phosgene	46	9	9	3	—	2	—	2	2	3	—	3	1	2	1
Hydrochloric acid ...	1	4	2	3	1	2	1	3	—	2	—	2	2	1	3
Hydrocyanic acid ...	2	1	—	1	—	3	1	2[1]	4	3	1	1	—	1	1
Bitumen, creosote, tar, oil...	2	—	2	1	1	2	1	3	—	—	—	—	—	—	2
Other	115[4]	134[3]	89	36	64[7]	25	20[4]	32[1]	25[3]	37	43[3]	45[9]	25	25	30
Total	782[41]	776[55]	695[57]	450[55]	427[57]	243[13]	244[25]	229[14]	218[24]	242[30]	228[17]	265[17]	254[23]	237[21]	255[11]

The principal figures relate to cases: the raised figures to deaths.

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Two men in a squad of eight were overcome by gas while cleaning a crane gantry in the melting shop of a steelworks. The source of the gas was a main, outside the building, which had an explosion door the luting of which was afterwards found to be cracked. As the wall consisted of corrugated iron sheeting with 18 in. spacing between each sheet, the gas passed easily into the melting shop near the workers on the gantry. The two men were lowered by their mates to the ground, where they lost consciousness; they recovered after treatment by artificial respiration and oxygen.

Power Gas

Eighteen cases, including one fatality, were caused by power gas, compared with 28 cases, including 2 fatalities, in 1954.

The fatal case was a fitter, aged 53, who with his mate was repairing a poke-hole, the casting of which had broken away from the top plate of a gas producer. The poke-hole was closed with a tapered wooden plug and sacking while a new bolt was being fitted. No special provision was made to reduce the risk of gas escaping but when this accident occurred the producer was working much below normal operating pressure. In addition to resuscitation apparatus, face pieces and tubing were available at the works to permit of breathing from a distance, but this apparatus was not used. While his mate was away, the fitter was seen to be affected by gas and was assisted down a ladder, at the bottom of which he collapsed. After treatment with resuscitation apparatus he recovered and was smoking a cigarette when the ambulance attendant arrived shortly afterwards. The attendant found his pulse to be normal and after staying with him about a quarter of an hour considered it safe to leave him and started to return to the ambulance room but was recalled. When he returned he could not feel the pulse and applied artificial respiration and oxygen for one hour pending the arrival of a doctor, who found the fitter to be dead. Post-mortem examination revealed severe arteriosclerosis, coronary thrombosis and long-standing massive pneumoconiosis, but no evidence of the absorption of carbon monoxide was found. It was considered that the large amount of oxygen and long period of artificial respiration given may have been the reason for the latter finding. The verdict at the inquest was death due to natural causes accelerated by the inhalation of poisonous gases.

Eight cases occurred during the charging of gas producers, two of them being due to blockages at the bell and two to blockages caused by frozen coke in the hoppers. One of these cases resulted from the failure of a gas plant operator to use the safety measures available, although he had been affected by gas only a few minutes before. Suspecting frozen coke was obstructing the passage from the bunker to the hopper, the operator closed the bell valve, but did not switch on a large fan which would have provided a strong current of air to disperse any gas which might have been present. After arranging, according to works rule, for another man to stand by, he connected the ladder extension and went up to the platform above. He attempted to free the coke but felt giddy and was assisted down the ladder. He soon recovered, again ascended to the platform without switching on the fan and was overcome. He was rescued by the man standing by, who also failed to switch on the fan or to use breathing apparatus which was available 20 ft. away. Fortunately, the operator recovered after treatment with artificial respiration and oxygen, which was continued in the ambulance during his removal to hospital.

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Coal Gas

Forty-three cases, including 3 fatalities, were reported during the year, compared with 34 cases, including 4 fatalities, in the previous year. Twenty-seven of these cases, including one fatal case, occurred in gasworks.

A gasholder attendant, aged 58, came to work at 10 p.m. and was found dead in an office the following morning. He had made himself a bed on a bench in this office and during the night, while asleep, had pushed a sliding desk against a portable recording instrument, forcing off a gas pipe which fell on to the floor just below his face. Another fatal case was a female industrial nurse, aged 69, who was found dead in a first aid room, measuring 10 ft. 6 in. by 7 ft. 6 in. and 11 ft. 6 in. high, in which a gas water-heater was fitted. A foreman, smelling gas and getting no reply on knocking at the locked door, obtained a duplicate key and entered the room, where he found the nurse slumped over a first aid couch. Post-mortem examination showed hypostasis of a cherry red colour over the back, the blood being fluid with 70 per cent saturation with carboxyhaemoglobin, and the internal organs also cherry red in colour. The firm carried out their own maintenance of this water-heater and had arranged with a plumber to check the appliance every six months. This had not been done for at least seven months and the heater-jet was found to be partly choked.

The remaining fatal case in this group was a mains-laying foreman, aged 53, who, assisted by a jointer, had drilled a hole in a 6 in. low-pressure gas main in a shallow trench preparatory to connecting a service pipe and had plugged the hole at the end of the day. The following morning, the jointer, having missed his train, arrived late and found the foreman lying with his head over the open hole from which gas was escaping. It appeared that the deceased had tried to fit a heavy metal collar round the pipe while making the joint and had accidentally moved some adhesive plaster which he had fixed over the hole after removing the plug. The contractor's instructions were that men should not work alone on this kind of work, that gas masks should be worn and stop valves turned off if necessary. Being an experienced man, the deceased no doubt thought he could do the job alone without taking these precautions, and it was probable that had the jointer been there this accident would not have occurred. Post-mortem examination showed at least 50 per cent saturation of the blood with carboxyhaemoglobin.

After complete overhaul of plant in a gasworks, in order to provide protection from the weather, an aluminium sheet canopy had been fitted over the travelling bridge used when the lids of the purifier were lifted. The lids had been lifted without trouble on two occasions after the canopy was fitted but on the day of this accident there was practically no wind. Supervised by the chief engineer, eight men went on to the bridge to turn the hand-wheels to raise the lid. Before the lid was fully raised, the eight men were seen to be suffering from the effects of gas and all were rescued, given first aid treatment with oxygen and removed to hospital, where two of them were detained. The canopy was not fitted with louvres and was fully enclosed at one end. Steps have been taken to ensure adequate ventilation under the canopy.

One accident illustrates the danger of taking a "calculated risk" with a gas as treacherous as carbon monoxide. After a purifier box in a gasworks had been empty for a few days with the valves closed, a leak developed in the inlet valve. The engineer, faced with the alternative of reducing gas production during the prevailing cold weather, decided to fill the box, taking the "maximum possible precautions". He mustered all the available men, opened all windows, provided screens to utilize any wind, arranged for

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oxygen apparatus to be available and instructed the men to work in turn, 10 minutes on and 10 minutes off duty. Despite these precautions, a labourer, aged 56, reported that he was being affected but returned to work without being authorized; he then became unconscious, and after treatment with oxygen was removed to hospital, where he recovered.

Other Causes of Carbon Monoxide Poisoning

Thirty-two cases, of which one was fatal, were included in this group. The fatal case was a steel-erector, aged 26, who was with another man on a permanent platform with two handrails, about 20 ft. above the ground, working on a gasholder containing water gas. The men were fixing a patch to the side of the gasholder to stop a leak and although the steel-erector had worked for two years on gasholder construction he had never before worked on a holder containing gas. Both men were wearing full-face breathing apparatus attached to free air lines 20 ft. long, but the erector had fitted the apparatus over the beret which he was wearing, although he had been instructed in its proper use. His mate had objected to this, but a test appeared to show that the apparatus was working satisfactorily. After working for about five minutes the erector was seen to stagger along the platform holding his mask. One of his legs entered the water-seal, and as he attempted to pull himself up he fell under the bottom handrail to the ground. He was immediately removed by ambulance to hospital, where he died about two hours later from a fractured skull and laceration of the brain, due to the fall following the inhalation of carbon monoxide. There is little doubt that the inhalation of gas was due to the deceased wearing the face-piece of his breathing apparatus over his beret.

Five contractor's men, erecting new uptakes over the cupolas in an iron foundry, were gassed in circumstances which might have been avoided had there been better co-operation between the contractors and the occupiers. Work on numbers 4 and 5 cupolas had been completed and number 4 was in use, while numbers 1 and 2 were not in use. The men were fitting a new cowl over number 3 cupola and for some time felt no ill-effect from fumes emitted from the adjacent uptake. The wind changed, however, and fumes were blown in the direction of the men at work on the scaffolding, who began to be affected. Fortunately, the foreman visited the site and, realizing the situation, ordered the men off the scaffold. Four of the men lost consciousness and all were successfully treated by the works medical officer. The work could have been completed under safer conditions had the foundry manager realized that number 1 cupola was ready for use and could have been brought into operation instead of number 4, which was adjacent to the one the men were repairing.

Three men were gassed by carbon monoxide during the construction of a pit 18 ft. by 12 ft. and 38 ft. deep in a sewage-disposal plant. A pump, driven by a petrol engine, had been started to keep down the level of the water which was seeping in at the bottom of the pit, the only access to which was an opening, 2 ft. by 4 ft. 6 in., in the concrete roof. A labourer, using a pneumatic tool operated from a compressor outside the pit, began to feel dizzy, and as he approached the ladder to climb out he became unconscious. He was seen by a stand-by man outside the pit, who also lost consciousness when he climbed down to attempt rescue. A ganger who had been called then entered the pit but fell off the ladder to the bottom of the pit, suffering multiple fractures. By this time the site foreman had arrived and he prevented any further attempts at rescue until the arrival of the fire brigade, who, using breathing apparatus, rescued the three men.

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Sulphuretted Hydrogen

Five cases were reported, compared with 13 cases, including 2 fatalities, in 1954. The five men concerned, in four accidents, were all rendered unconscious but recovered after treatment.

In a chemical factory, the normal process of treating liquors containing excess sulphide or hydrosulphide was to add hydrochloric acid in special enclosed reaction vessels fitted with exhaust ventilation. A process man, having shovelled residues in the form of a sludge from a cask into the reaction vessels, found that some of the residues had solidified at the bottom of the cask. In order to thin them down, he added hydrochloric acid direct to the contents of the cask, when there was an immediate evolution of sulphuretted hydrogen. He left the shed and shouted a warning to another workman, but both men were overcome when they attempted to open the windows, and were rescued by a third workman who was attracted by their calls. Both men were unconscious for some hours and were given oxygen treatment by the works medical officer before removal, under his supervision, to hospital, where they recovered.

During the fitting of a new pipe in a rayon yarn factory, a labourer carried a block, to be used for raising a heavy section of pipe, on to staging about 15 ft. above the ground. Shortly after, he was overcome by gas, let the block fall and then fell unconscious to the ground, sustaining injuries to his right leg and arm. He recovered after treatment in the works surgery, but was removed to hospital for observation. Near the place where he was working were header tanks, containing a saturated solution of sulphuretted hydrogen, which were merely vented to the apex of the roof. Tests taken at this place a quarter of an hour after the accident showed concentrations between 80 and 150 parts per million, the safety standard of working in the factory being 8 parts per million. Following this accident, the air spaces in all the tanks were vented to foul mains.

Following the discovery of a leak at a rotary valve on an electric arc furnace used for the preparation of carbon bisulphide, the manager decided that breathing apparatus was necessary while repairs were being effected and he issued a permit-to-work certificate accordingly. Without being instructed to do so, a labourer climbed up a ladder to the top of the furnace. He was not wearing breathing apparatus and, being overcome by escaping gas, he fell to the ground about 10 ft. below. After recovering consciousness he was able to walk to the ambulance room where he was treated for contusions to his right arm, left elbow, right knee and forehead.

A contractor's labourer was engaged on repairs to a sewer into which organic liquids from a chemical works leaked from time to time. After descending a manhole, he suggested to his mate that they should climb out because of the smell of gas. His mate did so but the labourer failed to follow him. Two men in turn went down but were unable to move the labourer. When the fire brigade arrived seven minutes later, two firemen, wearing breathing apparatus and equipped with ropes, were able to effect a rescue. The contractors had no means of testing the atmosphere in the sewer, nor were breathing apparatus, oxygen or ropes available. The labourer was given artificial respiration and removed to hospital, where he recovered.

Sulphur Dioxide

The 15 cases reported during the year resulted from 12 accidents, two cases occurring in three of the accidents reported. Four of the accidents, in which six workers were involved, occurred in two oil refineries. In one of

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these, a cloud of sulphur dioxide gas from a leak in a pipeline of the liquid moved across a yard into a pumphouse where two pumpmen, aged 39 and 60, were working. They shut the doors of the pumphouse, telephoned for the ambulance and went out to meet it, one of them collapsing just as it arrived. Both men suffered from a burning sensation of the mouth and throat, smarting eyes, difficulty in breathing and cough. In the other accident at this refinery, a pipe fitter's clothing (acid-resisting) was splashed with liquid sulphur dioxide when he opened up a joint in which it was believed there was no pressure. He was wearing breathing apparatus but was affected by fumes given off from his clothing when the apparatus was removed; he also suffered burns of the scrotum and right knee.

A fitter and his mate, aged 27 and 52 respectively, were gassed during a major overhaul at the sulphur dioxide plant in another refinery. As pockets of gas were being released from time to time, large quantities of fresh air were being pumped in and all men were supplied with respirators, which they were told to wear if they went above ground level and also when working at ground level if there was any gas present. Having worked aloft, the fitter and his mate descended to ground level, walked into a pocket of gas about which they had not been warned, and were slightly affected, both of them suffering from headache and cough.

Two labourers, aged 25 and 30, who were employed by a firm of scrap merchants to dismantle a disused gas-producer plant in an iron foundry, were affected while they were using an oxyacetylene burner without wearing breathing apparatus. After feeling unwell for a few days, and without having visited the firm's ambulance room, they reported to a hospital, suffering from weakness of the legs, vomiting, lachrymation, nose bleeding and tightness of the chest. Sulphur dioxide is liable to be produced during the burning of plant on which sulphur is deposited, and appropriate breathing apparatus should always be used in such circumstances.

Chlorine

There were 24 cases of gassing by chlorine, compared with 25 cases in the previous year.

In four cases, in which only slight exposure to chlorine gas occurred, the effects were stated to have been aggravated by the existence of a previous chest condition. One of these cases was a plant operator who inhaled a whiff of chlorine when adding hydrochloric acid to a reaction vessel under negative pressure, after having put in a slurry of sodium chlorite. He suffered from acute dyspnoea, spasmodic cough and acute asthma. The doctor who treated him in hospital considered that the inhalation of a small amount of chlorine had "triggered off" an acute attack in a man subject to asthma. A process operator, aged 32, whose exposure to chlorine from a leak in a plant for the chlorination of dimethylacetal was slight, suffered from cough, breathlessness and pain in the chest. The chest physician, who found a lesion in the left upper zone and kept him under observation at rest at home to assess the activity of the tuberculous lesion, thought the infection was a factor greater than chlorine exposure in this case. A night watchman, aged 58, said to have had a previous chest condition, suffered from a sensation of choking, cough and respiratory tightness following a slight leak of chlorine from a control valve. The fourth case in this group was a fitter, aged 57, who, with other men, was cleaning an air-cooler plant from which some water containing 4 parts per million of chlorine was leaking. The other men were unaffected by the small amount of chlorine, but the fitter, who was stated to be a heavy smoker, which caused him to cough continuously, became unconscious and suffered from lachrymation and cough.

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Two cases were due to carelessness in the disposal of waste chemical solutions. In one case, a cleaner, aged 43, was affected when he emptied, in quick succession into a drain, two bowls containing respectively solutions of sodium bisulphite and sodium hypochlorite, used for removing colour from the hands of dyehouse workers. He suffered from shortness of breath, for which he was treated with oxygen at the works before admission to hospital, where he was detained for four days. He had failed to carry out his instructions to flush the drain thoroughly before emptying the second bowl. A somewhat similar case was a jig dyer, aged 34, who poured into a drain already containing diluted bleaching liquor, an excess of sodium hypochlorite, instead of returning it to a carboy, and also got rid of some hydrochloric acid in the same way.

A fitter, aged 60, suffered from smarting of the mouth and throat and shortness of breath, which became increasingly severe, after disconnecting a drum of chlorine at which a valve had developed a leak. He had worn a respirator while doing this work but investigation showed that he had been issued in error with a wrong type of respirator.

After repairs to a joint in a chlorinating tank on the third floor of a paper factory, the chlorine was turned on and a fine spray of chlorine was ejected from the joint. An apprentice plumber, aged 19, and two other men immediately made for the stairway but the plumber returned to see why the joint was leaking. He was immediately affected by the gas and staggered to a window, where he remained until he was rescued. Fortunately, the attendant had heard the men's shouts and turned off the chlorine, after which the gas quickly dispersed. The plumber, who was semi-conscious and dyspnoeic, remained away from work for over three weeks.

Nitrous Fumes

Ten accidents, in which fifteen men were affected by nitrous fumes, were reported, four men being concerned in one accident and three in another, in each of which oxypropane burners were being used. Three other accidents resulted from the use of oxyacetylene burners in enclosed spaces.

Ten men were replacing the cross-head of a ship's rudder in the steering-gear compartment which measured 22 ft. by 14 ft. by 8 ft. The foreman fitter in charge sent a message requesting that an extraction fan be provided but, as this did not arrive and as the ship was scheduled to sail the next day, he decided to start the work. Three oxypropane burners were used to heat up the cross-head, the work being completed in about two hours. About half-an-hour after the work was started, one or two men felt rather ill but continued to work. Some hours later, eight of the ten men suffered some measure of discomfort and in four of them the delayed symptoms and signs were sufficiently severe to cause absence from work. One of the reported cases complained of tightness in the chest, palpitation and productive cough, with gastric upset. A second, who had at the time felt faint, sleepy and sick, developed, twenty-four hours later, tightness in his chest, with mild rigors. Forty-eight hours after the incident he noticed that his urine was dark in colour. A third man complained of tightness of the chest with cough that night, and later developed basal congestion; he, too, reported his urine to be dark in colour forty-eight hours later. The significance, if any, of these observed colour changes in the urine was not known. The fourth case was quite atypical and possibly the result of suggestion. He complained at the time of feeling giddy, with tightness of the chest, but remained at work for a fortnight without reporting to the ambulance room and then went off work complaining of giddiness and an irritable cough. Officials of the firm

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appeared to be unaware of the possible risks associated with this type of work, and the need to provide adequate exhaust ventilation when working in such confined spaces as the steering compartments of ships was stressed.

The other accident following the use of oxypropane burners occurred during the erection of a pressure vessel, 37 ft. in diameter and 50 ft. high overall, in which three men were using these burners to pre-heat the plates before welding. There were a number of manholes open at the bottom of the vessel and four openings 4 ft. in diameter in the sides, but the only openings above working level were 12 in. diameter holes in the dome, most of which were capped at the time. It appeared that there was very little air movement at the top of the vessel and that the men were working in a pocket of fume. After working for about three-quarters of an hour, the three men got out as quickly as possible, because of the fumes, but they did other work outside for about an hour before reporting to the ambulance room. They then suffered from nausea, vomiting and dyspnoea and one of them was detained in hospital for two-and-a-half weeks, where he was treated for pneumonia.

The three oxyacetylene burner cases reported were all caused by using this gas in confined spaces without exhaust ventilation. Two of the men concerned were burning rivet heads, one in a ship and the other inside a laundry boiler under repair, while the third man was applying heat in order to straighten a bar in the false bottom of a ship. In addition to their immediate symptoms, all these men developed deferred symptoms of shortness of breath, one of them also suffering from congestion of the lungs.

Two cases occurred at nitration plant in explosives factories, one case being due to an overflow at a spent acid tank. After turning off the pump switch in a room remote from the tank, the process man, aged 41, returned to open the drain-cock at the bottom of the tank, and in so doing inhaled some gas, which affected him half-an-hour later. He subsequently developed chest pain, cough, haemoptysis, acute bronchitis and bronchopneumonia. A process worker, aged 40, at another explosives factory, failed to maintain the correct steam pressure in an acid de-nitration plant where nitric oxides were being removed from sulphuric acid. Instead of shutting off the acid from outside the building, he attempted to avert a complete shut-down by using valves inside the building. The escaping oxides of nitrogen caused unconsciousness for several minutes, the deferred effects being headache, nausea, cough, profuse sputum, chest constriction and breathlessness. In both these cases suitable respirators were available, but were not used.

Ammonia

Twenty-one cases, including one fatality, were reported compared with nine cases, also including one fatality, during the previous year. These cases resulted from eleven accidents, in one of which seven persons, in another four persons and in a third two persons, were gassed by ammonia.

The fatal case was a filling-station attendant, aged 51, in a heavy chemical factory in which there was a works rule that a fitter should make the connections, supervise the filling and then disconnect from filled wagon tanks. As the fitter was carrying out a repair in the vicinity, the attendant coupled up to a wagon tank using only two of the flange bolts instead of the four provided. When the ammonia started to flow he noticed a small leak and went on to the wagon to tighten the joint. While he was doing this a spurt of ammonia struck him in the face. He was taken to the ambulance room for treatment by the works medical officer before being admitted to hospital, where he died from burns, pulmonary oedema and peripheral circulatory

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failure. Examination in the operating theatre disclosed third degree burns of forehead, eyelids, orbital regions, and right side of the neck and ear; burns, mainly second degree, of the chest, extending down to the umbilicus; burns of the left arm, right wrist, lips and tip of tongue. He was treated by penicillin intramuscularly and glucose saline, special attention being paid to the cleaning of the nose and mouth. The possible development of chest complications was foreseen and, although he seemed reasonably well when he left the theatre, his condition deteriorated during the afternoon and he died the same day. The standard of safety in this factory is very good but it was found that occasionally, without the knowledge of the management, the filling attendant did the coupling up and also that the men had been in the habit of leaving the breathing apparatus in the cabin on the filling platform.

One afternoon, while the engine-room foreman of an ice-cream factory was standing near an oil separating unit, there was a report and ammonia liquid and gas issued from the sump. It was later found that the rubber seal between the sighting-glass housing and the sump had "blown". The engine-room was immediately evacuated, the foreman taking with him a canister respirator from a rack. The fire brigade was called and warning given to all employees in the factory. As the concentration of gas was too high for the canister respirator, the foreman was unable to re-enter the engine-room to reach the ammonia isolating valve. The gas spread rapidly through the factory area and many of the hundred employees, most of them women, were affected. There was some degree of panic and some women were rescued from the canteen by firemen. Sixteen women employees and two firemen were admitted to hospital but only three persons were detained overnight. Seven of the women were sufficiently affected to require notification. Occupants of houses within a radius of fifty yards of the factory were also affected. The firm had already been advised to provide self-contained breathing apparatus and they were again advised to keep apparatus of this kind outside the engine-room as well as the canister respirators.

As the result of a leak in an ammonia compressor, followed three minutes later by an explosion, four reportable cases of gassing by ammonia occurred, all of whom were treated in hospital. As soon as the leak was noticed, the ammonia alarm was sounded and five hundred people employed in the factory block left the building. As the fumes were too dense, it was not possible to switch off the pumps nor was it possible to reach the main switches as they were in a locked substation, the keys of which were in the possession of the electrician who was in another part of the factory. One of the reported cases was a liftman, aged 28, who felt the shock of the explosion and then became unconscious for an unknown period. On admission to hospital he had an erythematous rash on the upper part of the chest and shoulders, inflamed fauces, and scattered rhonchi all over the lungs, especially the bases. Another man, a refrigeration engineer, aged 64, was proceeding to turn off the ammonia valve when the explosion occurred, saturating him with ammonia. He did not lose consciousness but felt burning pains in his mouth, throat and left leg. In hospital he was found to have confusion, with some increase in the deafness from which he suffered, excessive lachrymation, congested conjunctivae, photophobia, excoriations of his buccal and pharyngeal mucosa, abrasions of the left shin, second degree burns of the left ankle, and crepitations in the bases of both lungs. The third case was a chargehand fitter, aged 46, who suffered from dyspnoea, slight pain in the chest, lachrymation and nausea. The remaining reported case in this accident was a storeman, aged 29, who, after coughing and gasping for breath while exposed to the gas, suffered from cough, headache and discharging eyes while in hospital.

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A fitter, formerly employed by a firm of refrigerating plant engineers, was engaged, by a private arrangement, to dismantle and repair a refrigeration plant in a brewery. While removing bolts, there was a spurt of residual ammonia which slightly affected him and caused a labourer, aged 30, who was assisting him, to lose consciousness and subsequently to suffer from haemoptysis.

BENZOL

Seven cases, including two fatalities, were reported, compared with two cases in the previous year.

In one accident a labourer, aged 23, was fatally gassed and an ambulance room attendant and a fireman were also gassed while attempting to rescue him. The foreman had given instructions for four of a series of sixteen benzol tanks to be cleaned after they had been steamed out, tested and declared free from gas. While the labourer, with his workmate, was preparing to start work on a tank which had been steamed out, he enquired about another tank which had not been steamed and was told they were not instructed to clean that tank. When the workmate returned after fetching a respirator and a lifeline, he saw that a ladder and hose pipe had been lowered into the unsteamed tank and that the labourer had unaccountably entered without a lifeline or respirator. After shouting for help he attempted to enter the tank, at the bottom of which there was about 12 in. of liquid, but was forced to come out because of the fumes. During the rescue operations a fireman, who in his hurry entered the tank without a mask, was gassed, as was the ambulance room attendant, who had donned a fresh-air mask and a lifeline but dislodged his face mask while in the tank and lost consciousness. The labourer was given artificial respiration and oxygen but failed to recover. Post-mortem findings included extensive blistering and post-mortem lividity, bile-stained froth in the bronchi, and slight oedema of the lungs. There appeared to be a smell of benzene from the cerebro-spinal fluid and the brain was congested, with numerous petechiae over the cerebrum but not many in the cerebellum.

The other fatal case was a benzol house attendant, aged 47, who was found lying prone and unconscious on the floor, which was saturated with benzol. He was immediately dragged into the open air and artificial respiration was started at once, this being continued with the aid of a rocking stretcher, oxygen also being given. Despite this treatment, he was found to be dead on arrival in hospital. When the distillation temperature had been reached it was the attendant's duty to reduce the steam sufficiently to allow distillation to proceed in the normal manner. If this was not done, the crude motor spirit would boil rapidly and would eventually overflow on to the floor. After the accident, the plant was found to be in order, and it was assumed that the accident was due to the use of too much steam. A post-mortem examination disclosed that the face and back were deep blue in colour and that there were burns, caused by the liquid on the floor, on the front of the chest, right thigh and right foot, as well as numerous small burns on the rest of the body. The blood was very fluid and dark blue; there was a strong smell of benzol in the chest cavity, windpipe and both lungs. Death was due to respiratory failure, resulting from the inhalation of benzol vapour.

One accident brought to light a dangerous practice which had been carried out for some time. It appeared that a labourer, as was his custom, had added some crude benzol to a pail of water to facilitate the removal of grease from the tiles of a pump-house, but on this occasion had exceeded the usual measure of a mug of benzol to two gallons of water. As a result, he suffered from giddiness, sickness, headache and weakness, for which he received three days' hospital treatment. Following this accident a harmless substitute was used.

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Petrol and Benzine

Four cases, one of which was fatal, were reported. The fatal case was a laboratory boy, aged 16, at an oil refinery. He was found unconscious on the top of a benzine storage tank, 50 ft. in diameter and 35 ft. high, by another boy who had been sent to find him, as his absence from the laboratory was longer than expected. When found he was lying face downwards with his head and shoulders over the uncovered 24-in. diameter manhole, his right arm being inside the opening. A half-gallon metal can was floating on top of the benzine inside the tank, with its attached cord reaching out through the manhole under his body. The boy who found the deceased, after moving him, went for aid, but despite treatment, including artificial respiration and the use of resuscitation apparatus by the two works doctors, he did not recover. It appeared that, instead of lowering a sample jar about five or six times through the 4-in. diameter dip-hatch provided, he had tried to fill the half-gallon can by lowering it through the open manhole into the benzine. The can, tied on the end of a cord, being of light weight, would be difficult to sink into the benzine 5 ft. below and the deceased probably spent some considerable time, with his face over the open manhole, endeavouring to sink the can. The deceased had been employed for about seven months, and after being warned of the danger of fume, had been sampling for several months. He was very well spoken of by his supervisors. At the inquest a pathologist said the cause of death was asphyxia following inhalation of an irritant vapour, and that death must have occurred within a period of minutes.

A paint sprayer, aged 26, was gassed while spraying a room in a fire station with an interior cellulose enamel containing a petroleum product. After working for about an hour and a half, he was seen to stagger out of the room and then to become unconscious. The personnel of the fire station commenced artificial respiration in the open air before sending for a doctor, who sent him in an ambulance to hospital, where oxygen was administered and he was detained for three days. It was thought that the predisposing factors in this case were very poor through ventilation, there being limited window space and, as all the windows were 4 ft. 8 in. above the floor, there was the possibility of a layer of fume having accumulated between the floor and the window level.

Trichlorethylene

Eighteen non-fatal cases were reported, this year being the first since 1946 in which no fatal case occurred. The fatal cases in the intervening years numbered five in 1950, two in 1947 and one in each of the other years.

Ten of the cases followed work at degreasing tanks, eight of them while operating the degreasing plant and two after draining trichlorethylene from the tanks. In one of the latter two accidents, a degreaser was affected while bending over a container, emptying warm trichlorethylene into a settling tank. In the other, the operator climbed into the pit under the degreasing tank to tighten the cleaning door from which the trichlorethylene, which he was pumping into the tank, was leaking. This man became unconscious, but fortunately was seen and removed to the first aid centre, where he recovered.

One of the cases which resulted from the operation of a degreasing tank was that of a labourer, aged 19, who a fortnight later was again found unconscious, suffering from the effects of trichlorethylene. On the first occasion, after lowering baskets of aluminium ware on pulley blocks into the degreasing tank during his first afternoon alone on this work, he was found unconscious beside the tank. He was unconscious for about an hour, and received five days' hospital treatment. During the investigation of this

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accident it was discovered that he had been discharged from the Army because of a " breakdown " and he admitted to the Appointed Factory Doctor that he " quite liked " the smell of trichlorethylene. After this occurrence he was given instructions that he must on no account go near the degreasing plant, and was put on other work. Two weeks later, he was found unconscious in a lavatory at six o'clock in the evening, with trichlorethylene in a small saucepan nearby. It was thought that he had obtained the trichlorethylene during the lunch-break and had been inhaling it at intervals during the afternoon. He was found by the works' caretaker and removed to hospital, from which he was later transferred, as a voluntary patient, to a mental hospital. This man was obviously mentally unstable and had developed an addiction to trichlorethylene.

A tank cleaner, aged 29, and an apprentice plumber, aged 17, were gassed by trichlorethylene in unusual circumstances while a double-bottom fresh water tank of a vessel in a ship-repairing yard was being cleaned out. As some adjustment to the engine holding-down bolts was required, it was necessary for fitters to enter the tank. Accordingly the tank, which one week previously had been filled with fresh water, was drained, and the cleaner and his mate entered through a manhole 24 in. by 14 in. and proceeded to bale out residual water through a tap hole in the shell. When, after working for about an hour, they came out for a break, they reported a " funny smell " but no action was taken. The cleaner then re-entered the tank but collapsed soon afterwards, and the apprentice plumber, who entered the tank to investigate, also collapsed. Both men were finally removed from the tank in an unconscious condition by another plumber and the first aid man, and recovered after treatment with oxygen. Investigation disclosed that when the tank was being filled with fresh water a condenser in the engine-room above was being degreased with trichlorethylene. It was highly probable that some of this had either leaked, or been spilled from drums, on to the engine-room floor and entered the open manhole of the water tank. The trichlorethylene would lie at the bottom of the tank, sealed by water, until finally disturbed by splashing when the residual water was being removed.

A general labourer, aged 55, and his mate were, on a Saturday afternoon, cleaning out the sludge and small metal particles from an oil sump 4 ft. square by 5 ft. deep, the purpose of which was to receive oil and other liquids spun off from metal swarf collected from various parts of the factory. They started work at 1.30 p.m. and during the course of the afternoon were seen from time to time by the fireman during his routine patrols. He noticed that the two men (usually of sullen disposition) were becoming increasingly cheerful as the day wore on, but did not at the time attach any special significance to this. They waved cheerily to him at 5.35 p.m. and the next thing known was that at 7.40 p.m. one of the men stumbled into his office saying that the labourer was unconscious at the bottom of the sump. This man could not remember anything that had happened after 5 p.m. The unconscious man was quickly removed to hospital, where he recovered after remaining unconscious for a further twenty-two hours. The atmosphere of the sump was subsequently found to be heavily laden with trichlorethylene fume. Following this accident, it was found that this substance had been widely used for unauthorized purposes, such as cleaning overalls and possibly for cleaning floors, and had found its way into the sump, either by being tipped into the swarf bins, or directly from the floor of the factory.

Although not a reportable case, a death alleged to be due to trichlorethylene poisoning is of interest. The deceased, who was 21 years of age, had been employed at a trichlorethylene degreasing plant for about two

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months, during which time he complained of drowsiness and sleepiness when he arrived home from work. In May, 1955, he visited his doctor complaining of diarrhoea, and early in July, 1955, he was again seen by his doctor, as he was suffering from headache and lassitude. On examination, no cause could be found for his symptoms, blood examination at that time being normal. On 15th July, he complained of an irritating vesicular rash on his hands and forearms and was put off work. A few days later he was pyrexial and had an acute eczematous condition on his face and an erythematous condition on the trunk and upper parts of his limbs. As he did not improve, he was admitted to hospital on 27th July, where he died two days later from uraemia. After a post-mortem examination the pathologist came to the conclusion that death was due to an acute interstitial nephritis and exfoliative dermatitis, death being due principally to failure of kidney function. He was not able to associate death entirely with trichlorethylene, which may have been the cause of the dermatitis, the inflammation of the kidney being secondary to this. The jury returned a verdict of accidental death.

It appeared that the deceased had from time to time inhaled enough trichlorethylene to cause dizziness and lassitude and the evidence showed that the control of the fume was unsatisfactory. On the other hand, it was not certain that the dermatitis was due to trichlorethylene, and exfoliative dermatitis and interstitial nephritis are not characteristic of exposure to this substance.

Nickel Carbonyl

The only case reported was an operator, aged 60, who was attending to a decomposer for producing nickel powder, as distinct from pellets. By means of a spirit-lamp test, he discovered a leak around the gland through which passed a rod operating a manually-operated shaker. He proceeded to tighten this gland and finished his shift. The following day he felt as if he were suffering from influenza, but nevertheless worked throughout the day. On the next day's shift his chest felt tight, and after walking home he was gasping for breath. Despite this, he returned to work although he felt ill, but was then seen by his doctor, who gave him a medical certificate, which he forwarded to the factory. His symptoms were shortness of breath, acute pain in the chest, headache and nausea. The works medical officer visited the man at his home as soon as he became aware of the circumstances, but by that time blood and urine examinations were negative. The man should, of course, have carried out a standing instruction and reported to the works surgery as soon as he felt unwell. Investigation showed that, although fitters were provided with their own respirators for use when stopping leaks, no respirators were provided for emergency use in this department. This was remedied.

Phosgene

A mild case of phosgene gassing occurred in a process worker, aged 34, in a chemical factory where, owing to the accidental opening of the valve of a pipeline not intended to be used in the particular circumstances, phosgene escaped into an occupied building. Its presence was readily detected and workers in the vicinity moved to a safe place. The foreman and a charge-hand donned canister respirators and shut down the valve, thereby stopping the escape of gas. The process worker, who was more affected than his workmates, reported to the ambulance room suffering from cough, a choking sensation, weakness and dizziness; he was treated with oxygen, rest, coffee and a cough mixture, and was away from work for five days. Following this accident, alterations were made to the pipeline and padlocks were fitted to valves.

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Hydrochloric Acid

Three cases were reported, one being a chemical process worker aged 34, engaged on the manufacture of D.D.T., who was exposed to concentrated acid fumes when working with a batch in which crystallization had failed to occur. After working for about an hour over an open manhole, washing oleum from the emulsified batch, he became acutely dyspnoeic and, for a brief period, unconscious. He was carried to the ambulance room, where he was given artificial respiration and oxygen before being transferred to hospital. During his period of unconsciousness he stopped breathing for a minute or two, this being due, it was thought, to laryngospasm. The process in which he was engaged was not normally regarded as hazardous but it was subsequently included in the fume-extraction system.

Another case was a leading hand, aged 45, in an electro-chemical factory, who after filling a steam-heated tank with a carboy of hydrochloric acid was noticed to be suffering from cough and lachrymation. He was later sent to hospital, where during his stay of five days he was found to have bilateral corneal burns and, on X-ray examination, shadows in the first right inter-space, thought to be due to an old tubercular focus. This was a new factory in which a fan and trunking to draw off fumes were to be installed and it was suggested that a small hand-pump should also be provided for filling the tank.

Hydrocyanic Acid

A severe case of gassing by hydrogen cyanide occurred after the holds of a ship had been fumigated; following the completion of this work, the ship's Chief Officer had been supplied with a certificate that the holds were free from gas. On the following day, a Sunday, manholes which had been in position during the fumigation were removed in order to allow access for cleaning purposes to a fuel tank in the ship's bottom. Within a few minutes of the entry of five men into the tank, four of them emerged, saying they smelt gas. When it was discovered that one man remained in the tank, fans were fitted to the manholes to ventilate it and the men re-entered, to find their mate collapsed. Being unable to get him out of the manhole through which they had entered, they dragged him some distance through the floor-plate openings until he could be rescued through another manhole. Through an oversight, neither of the ambulance rooms in the shipyard was open, as the man in charge had not been notified that any work was to be done on the Sunday. Fortunately, however, an ambulance had been summoned and the man, a redleader, aged 35, was quickly taken to hospital, after being treated with artificial respiration and oxygen which, together with gastric lavage, was continued in hospital. He suffered from dizziness, difficulty in breathing, loss of consciousness; his deferred symptoms included headache, vomiting, pain in the throat, chest and abdomen, and weakness. Subsequent tests showed that cyanide was still present in the tank and it was evident that, although the manholes were said to have been properly closed and water-tight, they were not gas-tight. It was arranged that in future all double-bottom tanks would be tested before entry, after the fumigation of ships' holds.

Bitumen, Creosote, Tar, Oil

One accident occurred in which two painters, aged 70 and 61, were affected by fumes from burning bitumen and cork while working in a ship under construction. A welder was fitting a lug used for holding steel straps in position in a refrigeration chamber, which was being fitted with cork insulation after painting with bitumen. He omitted to take the precaution of covering the

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adjacent area with wet bags and sacking, and as a result a fire occurred. Smoke and fumes spread to another chamber where the two painters were working. There was another exit through which they could easily have escaped, but they lost their heads and had to be led out. Consequently, both men suffered from a good deal of respiratory and ocular irritation and psychological upset.

Other Gases

Phosphorus Oxychloride

Three cases of gassing by phosphorus oxychloride fumes were reported, the symptoms in each case including cough, dyspnoea and pain in the chest. One case, a very slight one, was due to fume arising from an empty drum, which had contained this substance, while it was being rolled on to a loading bay. Another case was a process worker, aged 49, who was affected while syphoning phosphorus oxychloride from a thirty-gallon lead drum. According to his account, the syphon was faulty but no fault was found on later inspection, although some of the substance had been spilt on the floor. This was thought to be due to mishandling or to overflow which he had tried to wash away. In this case, training had evidently been unsatisfactory and he was doing the job for the first time without supervision.

A maintenance fitter, aged 48, at a chemical works, inhaled a small amount of phosphorus oxychloride fume which escaped from a nearby plant, and suffered from smarting eyes, dyspnoea, pain in the chest, and cough with sputum, but did not lose time. Two days later, when opening a flange on a vessel which had been drained and left to stand for a day, he again inhaled some fumes. He had been issued with a respirator for this work but it was left to his discretion whether it should be used. After inhaling some fume he put on the respirator and finished the job, later reporting to the ambulance room suffering from similar symptoms, which gradually became worse and caused absence from work for one month.

Phosphorus Pentoxide

Two workmen, in a chemical factory where phosphorus was manufactured, were gassed, on separate occasions, by phosphorus pentoxide fumes. Projecting about 3 ft. above the top of a vessel in which condensed phosphorus was collected was a sight-tube used for estimating the level in the vessel, the phosphorus being covered by water, which filled the remainder of the tube. For some unexplained reason, although the collecting vessel was only half-full at the time, about a cupful of phosphorus escaped from this tube on to the surrounding metalwork and then fumed. Several men working on the floor above were exposed to the fumes, and as they made their way down they shouted to a fitter, aged 54, as they passed his floor. They found that he had not followed them and he was seen to be in a dazed condition by a man who went to the source of the fume to put out the fire. His own account was that, after staying where he was for about five minutes until the fumes cleared, he made his way to the first aid post where he collapsed. His next recollection was waking up in hospital while being treated with oxygen; his main symptom was dyspnoea which persisted for three days.

The other case at this factory was a rigger, aged 49, who, with four other men, was removing a centrifugal pump from a tank which received water used to condense phosphorus vapour. Small particles of phosphorus, which had not separated out and which were sticking to parts of the pump while submerged, took fire when exposed to air. The phosphorus pentoxide fumes thus generated were sufficient to cause him headaches, cough and dizziness,

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for which he was treated with oxygen in hospital but was discharged the same day. This man had previously been off work for a long period due to depression, although otherwise strong and fit. The other four men were not affected.

Metal Fume Fever

Among the cases reported was a burner, aged 27, who had been employed for several months in a scrap-yard, cutting galvanized tanks with an oxy-propane torch in the open. For two days he had been cutting more than the usual number of these tanks, together with other ungalvanized metals, when he reported to his doctor, suffering from difficulty in breathing followed by shivering, alternate hot and cold feelings and vomiting.

Also of interest, the employees at a metal-spraying factory, despite an elaborate if not very efficient system of local exhaust ventilation at the pistol spraying booths, complained, when spraying zinc, of nausea, gastritis and symptoms suggestive of metal fume fever. It was found that at another factory where the conditions were comparable, shot-blast helmets were always used in addition to local exhaust ventilation. As a result of favourable reports of this precaution, two experimental helmets, with an air supply tapped from the high-pressure supply to the spraying pistols, were obtained. These helmets, weighing less than 2 ounces, made of a thin gauge brown PVC with a clear PVC or plastic face-piece sewn in, could be tucked inside the overalls, and were found to be more comfortable to wear than a conventional shot-blast helmet. They were very well received by the employees, who had no symptoms while using them. Precautions such as this are general with metals such as lead, cadmium and tin, but it may be worth while adopting them also for the less toxic metals such as zinc and aluminium.

Aliphatic Hydrocarbons

A pipe-fitter, aged 26, was gassed by aliphatic hydrocarbon fumes in a pit 20 ft. by 10 ft. by 6 ft. deep in an oil refinery while he and another man were inserting a blank in a pipeline which had been shut off. Both men were wearing breathing apparatus supplied with air from a hand-pump, a Y-piece being used to supply the two sets of apparatus from a single pump. While working in the pit, the pipe-fitter, who was apprehensive and difficult to reassure, was seen to remove his mask. The safety attendant, who, with the foreman, was watching from ground level, replaced the mask and assured him that it was working properly. When the joint was opened, some liquid escaped owing to residual pressure, and the pipe-fitter endeavoured to come away, but was persuaded to return. Later, when he again attempted to leave the pit, his airline caught on the bottom of the handrail and impeded his exit. This caused him to panic and he took off his mask. The foreman and the safety attendant, running to his assistance, pulled him to safety as he collapsed. His workmate continued to work in the pit without any trouble. After being given artificial respiration and an injection of coramine, the pipe-fitter was removed to hospital where he recovered. The apparatus which he had been wearing was subsequently found to be in good order, but it was unwise to compel him to work under circumstances of which he was obviously afraid.

Methyl Isobutyl Ketone Fumes

A process worker, aged 62, in a paint factory was severely gassed by fumes of methyl isobutyl ketone which he was using to clean out a paint-mixing tank 5 ft. in height and 6 ft. 6 in. in diameter. He had entered the tank, taking with him an open five-gallon container of solvent, a mop, and a

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respirator which he stated he was wearing. He was found lying unconscious in the tank with his respirator lying nearby free from paint, although there was paint on the spectacles he was wearing, indicating that he had not worn his respirator. After artificial respiration had been applied, he was taken to hospital, suffering from extensive second degree burns of his back, down to the upper third of his thigh, left shoulder and arm, and left and right sides of the thoracic wall. Subsequent examination of the canister respirator revealed that it had been manufactured more than ten years previously and that it had not been renewed or examined in the meantime. An airline respirator which was available for use was also found to be poorly maintained.

Carbon Tetrachloride

A process worker, aged 44, was employed on a process in which carbon tetrachloride was used and for which, as there was some escape of fume, a canister type of respirator was provided. After complaining of the smell, he used his respirator, but some hours later felt ill with throbbing headache, vomiting and momentary loss of consciousness. When he returned to work three days later, he again complained of nausea and was off work for a further seven days, typically with persistence of nausea and anorexia.

Acetylene

The four cases of gassing by acetylene all occurred during the cutting of metal by means of an oxyacetylene flame. In one case a junction in the pipe caught on an obstruction, and was pulled apart. Inhalation of the escaping gas caused a fitter, aged 38, to collapse, semi-conscious, choking and vomiting. Deferred symptoms of shortness of breath, with constriction of the chest, caused eleven days' absence from work.

Chlormethyl Ether

A chemical processman, aged 26, complained of tightness of and pain in his chest, with giddiness and vomiting, which he ascribed to fumes of chlormethyl ether, of which small quantities were escaping from a leaking pump in a modern type semi-open chemical plant. This substance, which was being used in the manufacture of ion-exchange resins, is a very reactive and irritant compound which readily breaks down into hydrochloric acid, formaldehyde and ethyl alcohol. The chlormethyl ether itself, or formaldehyde, might have been responsible for the symptoms in this case, although other men working in the vicinity were not affected.

Unknown Causation

During the installation of a new pot concentrator, 8 ft. in diameter and 7 ft. high, built into the brickwork of an oil-fired furnace, with the top of the pot level with the top of the brickwork, a fitter's mate, aged 24, entered the pot to place a wooden wedge under the mixing paddle which was resting on the bottom. After he had done so, he was seen to collapse, and a fitter, aged 25, wearing a canister respirator, who attempted to rescue him, also collapsed in the pot. Both men were eventually rescued by a works fireman wearing an airline respirator. There was an oval opening 4 ft. long and 10 ft. wide across the centre and a manhole 20 in. in diameter towards one side of the top of the pot. For three days during installation men had frequently entered without trouble. The purpose of the plant was the concentration of sulphuric acid, and a feed-pipe for acid, not present earlier, had been placed in position before the fitter's mate entered the pot, no further entry being anticipated. Although the acid feed was blanked off, some dripping had occurred and there was some acid inside the pot when he

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entered. The would-be rescuer recovered consciousness rapidly but was off work for six days. The fitter's mate was unconscious for seven hours and off work for two weeks, chiefly on account of an acid burn of the left cheek, sustained while lying at the bottom of the pot. Neither of the men had been aware of any fumes, but some odourless gas must have been present, either with a toxic action of its own or to an extent such as to lead to dilution of oxygen below the level necessary for life. It seems possible that hydrogen may have been evolved by the action of the acid on the pot, but this presumably would have rapidly dispersed, being so much lighter than air.

CHAPTER 16

Industrial Poisoning and Diseases

PARTICULARS of the cases of industrial poisoning or disease notifiable under Section 66 of the Factories Act, 1937, or under Section 3 of the Lead Paint (Protection Against Poisoning) Act, 1926, showing comparison with the previous years, as given in Table 26.

LEAD POISONING

Sixty-nine cases of lead poisoning were reported, compared with 49 during the previous year, no fatal case occurring, for the sixth year in succession. The increase in notifications was mainly due to the larger number of cases in the categories "other contact with molten lead" and "other industries". Pottery, and coach and car painting, were the only classified industries in which no case occurred.

Smelting of Metals

The two cases reported were employed at different lead smelting works. In both, inadequate personal hygiene may have contributed. One of them, aged 42, who had been employed four years in all in a lead refinery, first as a general labourer and latterly, under good conditions, specifically as a lead smelter, was found at a medical examination to have a high punctate basophil count, with anaemia, and was suspended from work as a smelter. A few days later he developed abdominal colic and was admitted to hospital, where his punctate basophil count was found to be 5,000 per million red cells and haemoglobin 73 per cent; large amounts of coproporphyrin were found in the urine. He was successfully treated with calcium versenate.

The other was a process worker, aged 44, who, for about ten weeks before he was taken ill, had been charging a reverberatory furnace with old battery plates. Following a severe attack of abdominal pain with constipation, he was admitted to hospital, where he was found to have slight anaemia with marked punctate basophilia.

Plumbing and Soldering

One of the two cases included in this group had been employed for twenty-five years as a lead burner and fitter in ancillary work in a coke and by-product works. He occasionally used a respirator while burning and welding the metal. After suffering from attacks of sickness and constipation, he complained of weight in his arms, tightness of the chest and of continually feeling tired. Examination of the urine showed 255 micrograms of lead in a 24-hour specimen.

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TABLE 26

Industrial Diseases

Disease and Industries	Reported Cases									
	1910	1920	1930	1940	1950	1951	1952	1953	1954	1955
Lead poisoning	505[36]	289[44]	265[33]	108[6]	57	64	48	52	49	69
1. Smelting metals ...	34[5]	45[3]	37[1]	11	3	14	7	1	2	2
2. Plumbing and soldering	25[1]	3[1]	6[1]	4	1	2	1	—	1	2
3. Shipbreaking ...	—	3	24	6	27	5	4	8	9	4
4. Printing	33[4]	9	7	—	—	—	—	—	—	1
5. Other contact with molten lead ...	17[1]	13[3]	19[3]	21[1]	2	9	15	16	4	18
6. White and red lead works	44[1]	28	3[1]	17	4	3	2	1	7	2
7. Pottery	78[11]	25[13]	23[10]	6[3]	1	—	2	—	—	—
8. Vitreous enamelling	17	2	2	1[1]	2	4	—	1	—	1
9. Electric accumulator works	31	47[3]	36	15	7	8	8	11	18	11
10. Paint and colour works	17[1]	9	6[1]	7[1]	2	7	5	3	3	6
11. Coach and car painting	70[4]	13	10	—	—	1	—	—	—	—
12. Shipbuilding ...	21[3]	9	5[1]	1	1	1	—	—	—	1
13. Paint used in other industries ...	51[3]	10[1]	5	5	—	2	—	1	—	3
14. Other industries ...	67[3]	27[1]	16[1]	4	5	4	2	9	5	16
15. Painting of buildings	—	46[21]	66[13]	10	2	4	2	1	—	2
Phosphorus poisoning ...	—	—	—	—	—	—	—	—	—	2
Mercurial poisoning ...	10[1]	5	3	5	3	3	8	—	1	2
Arsenical poisoning ...	7	3	1	2[2]	—	3[1]	1	4	—	—
Manganese poisoning ...	—	—	—	—	—	—	1	—	1	—
Carbon bisulphide poisoning	—	—	—	1	—	1	—	—	—	1
Aniline poisoning ...	—	—	24	64	6	5	12	15	11	9
Chronic benzene poisoning	—	—	—	3[1]	2[1]	—	—	—	2[1]	1[1]
Toxic jaundice	—	6	—	20[4]	—	1	—	—	—	—
Toxic anaemia	—	—	—	—	—	1	3[1]	2	—	4
Compressed air illness ...	—	—	—	3[1]	46	4[1]	3	7	8[1]	8[1]
Anthrax	51[3]	48[11]	43[6]	37[5]	36	31[1]	20[1]	29[1]	18[1]	15
1. Wool	28[3]	25[7]	13[1]	17[3]	4	13	3	9[1]	9	5
2. Horsehair	6[1]	5[1]	1	2	—	1	—	1	—	—
3. Hides and skins ...	14[3]	17[3]	24[4]	13	26	11[1]	8	11	5	5
4. Other industries ...	3[3]	1	5[1]	5[3]	6	6	9[1]	8	4[1]	5
Epitheliomatous ulceration	—	45[1]	194[36]	166[12]	195[13]	178[1]	157[3]	256[44]	173[13]	211[16]
1. Pitch and Tar ...	—	42[1]	97[10]	119[4]	167[5]	159	126[1]	196[39]	143[3]	163[8]
2. Mineral Oils ...	—	3	97[26]	47[11]	28[3]	19[1]	31[1]	60[13]	30[3]	48[13]
Chrome ulceration ...	—	126	95	121	143	203	217	164	220	261
1. Manufacture of bichromates ...	—	77	6	14	36	80	87	65	103	104
2. Dyeing and finishing	—	43	15	6	—	1	—	1	1	—
3. Chrome tanning ...	—	4	5	4	—	—	4	3	—	—
4. Chromium plating	—	—	57	57	100	111	98	88	99	102
5. Other industries ...	—	2	12	40	7	11	28	7	17	55

The principal figures relate to cases, the raised figures to deaths. Fatal cases not reported in previous years are included as both cases and deaths.

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The other man, aged 40, was employed as an oxyacetylene burner in demolition work — often a serious risk where any lead material is present. His attack of lead poisoning followed a period of about one month, during which he was burning out lead jointing in pipes connecting scrubbers to condensers in a gas works. On admission to hospital he gave a history of abdominal pain, weakness of the knees, and obstinate constipation for eleven days. On examination, he was found to have a doubtful blue line on the gums, pallor and a slight weakness (bilateral) of the quadriceps muscles. Blood examination showed red blood cells 3,540,000 per cu.mm., haemoglobin 66 per cent, punctate basophils 5,000 per million red blood cells, anisocytosis and poikilocytosis.

Shipbreaking

The four cases reported were all burners in shipbreaking yards, where they were employed in the open. One, aged 29, was a severe case; he had been employed for only fifteen months, but for a few weeks of this period he had been exposed to an increased hazard while breaking up a ship which had not only a heavy coating of lead paint on the plates but also a thick deposit of read lead putty between the shell plates and the teak sheathing of the ship. He developed severe abdominal pain, for which he was admitted to hospital, where the blood findings and high lead urinary excretion were diagnostic.

Illness in another, aged 28, employed as a burner for two and a half years in an open yard, where preventive measures were well applied, began with nausea and mild colicky abdominal pains. When he became worse, complaining of general malaise, weakness, nausea, anorexia, pains in arms and legs, absolute constipation and severe abdominal colic, he was admitted to hospital. Here, blood examination showed haemoglobin 98 per cent, and punctate basophilia of 14,000 per million red blood cells.

Printing

No case had been notified in the printing industry for eleven years except for the death of a compositor, recorded in 1946 and ascribed at the inquest to chronic arteriosclerosis due to lead. The deceased was aged 77, had been employed for twenty-five years, and had virtually ceased work in 1932. In 1955, a typesetter, aged 22, employed eight years (less two years in the Forces) with a history of previous attacks, was notified as a case of lead poisoning. He had worked in a small, badly ventilated room in which were four monotype casting machines. The type metal consisted of 79 per cent lead, 15 per cent antimony and 6 per cent tin. Reliance had been placed on heat from the pots to take the fume up to an extraction fan in the roof, but investigation showed that, after rising about 10 ft., the fume fell back into the room. The typesetter was referred to hospital by his doctor because of recurring episodes of abdominal pain, anorexia, constipation, giddiness and headache. On clinical examination, he was found to be pale and anaemic, with tachycardia, but not otherwise abnormal. Examination of the blood revealed moderate anaemia, with a haemoglobin level which varied between 75 and 84 per cent, colour index of 1·0, a slightly raised reticulocyte count and punctate basophilia. His urine contained an excess of porphyrins. Examination six weeks later showed that he had recovered completely.

Other Contact with Molten Lead

Eighteen cases were reported from eight factories during the year.

Five cases were employed, by a firm of chemical engineers, on homogeneous lead welding of the interior of large steel vessels, no provision having been made for the removal of fumes. The men were wearing, as protection from

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the fume, improvised masks consisting of a pad of surgical gauze. Following a severe case of lead poisoning in 1949, a plenum system, but not localized extraction of fume, had been introduced, which gave only good general ventilation. Delay in notification led to delay in investigation and in the intensification of preventive measures. The first case suffered from abdominal colic in February, but was not notified by his doctor as a case of lead poisoning until June. The second case was admitted to hospital in May with symptoms suggestive of an acute abdomen, but the house surgeon suspected lead poisoning, which was later confirmed and notified. Both these cases had anaemia and a raised urinary lead excretion. The third case went sick in May and was notified by his doctor about two months afterwards. He suffered from abdominal colic and increased lead excretion, but his blood picture at the time of investigation was within normal limits. The two remaining cases were notified by the occupier, following a visit by a Medical Inspector. One had a blue line on his gums, a haemoglobin level of 70 per cent, punctate basophilia, a lead excretion of 0·3 mgm. in a 24-hour specimen and a recent history of a two weeks' illness diagnosed as "gastritis"; the other had a blue line, slight paresis of the left wrist and intrinsic hand muscles, a haemoglobin level of 80 per cent, raised punctate count and high urinary lead excretion. This man had no subjective symptoms. Tests in the factory for atmospheric lead level showed this to be about ten times the normally accepted threshold of 150 micrograms per cubic metre. The plenum system of ventilation was changed to an extraction system with flexible hoses bringing the points of extraction close to the working area of the burners.

Four cases, two classed as of slight and two of moderate severity, were reported from a scrap metal refinery, where other cases have occurred in recent years. These men suffered from abdominal pain and, among other signs or symptoms, vomiting, weakness and low haemoglobin levels; blood lead ranged up to over three times the normal amount and punctate basophils up to 14,600 per million red cells. Two of the men were working at reverberatory furnaces which were being replaced by rotary furnaces but which, owing to a breakdown, were used again, causing large quantities of fume to enter the air of the workshop. The other two men were lead refiners exposed to fumes arising from molten lead. In an effort to improve the conditions at this works, extensive alterations, including a new fume-extraction system, dust-settling chamber, and filtration house, have been carried out.

Two cases occurred in a wire mattress factory where, during heat treatment, steel wires were quenched in a lead bath 12 ft. long, containing molten lead to a depth of about 18 in. The wires emerged through a layer of sand, which wiped the lead from them, but some of the sand, mixed with lead, fell on the floor and formed a heap, which was shovelled back twice daily on to the bath surface. It was suggested that the exhaust hood covering the bath should be extended to cover the collection of the sand, the sand being put in closed containers. The first case notified was a labourer, aged 30, employed four months, who suffered from constipation, slight anaemia, pain in upper abdomen, cough and pain in chest, and vomiting of mucus in the morning; blood examination showed a punctate basophil count of 3,000 per million red cells. The other case, a wireman, aged 39, employed seven months intermittently, was admitted to hospital on three occasions, in the first instance for observation: on the second admission nothing abnormal was found during a laparotomy; the third admission was required because of a perforated duodenal ulcer, and it was following this operation that the further diagnosis of lead poisoning was made; during this period the punctate basophil count reached 12,000 per million red cells, and on de-leading, his urinary excretion of lead increased nearly twelve-fold. The working con-

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ditions are very good in this factory and the precise factors in the causation of these cases are a matter of surmise. Lead-contamination of the atmosphere caused by the use of air to cool the bath to 515°C., and manipulation of the lead-contaminated sand, are the only likely factors; both of these have now been dealt with.

A man, aged 50, a doubtful case, had been employed for nine months, partly in stripping lead sheeting from sulphuric acid chambers during demolition, and subsequently for one week in melting scrap lead in a lead pot with canopy and outside flue; he did no burning. It was while he was so engaged that he became ill, having to send for his doctor in the night. In addition to vomiting, he had abdominal colic with some muscle wasting, notably of the thighs. Blood examination showed red blood cells 4,600,000 per cu. mm., haemoglobin 91 per cent, while the stippled cell count fell from 4,000 per million to nil in the space of twelve days. The estimation of lead in the blood was obscured by the smallness of the sample but its value was in excess (132 micrograms per 100 ml.).

A furnace man, aged 30, employed for thirteen months at a firm manufacturing lead and lead alloys, consulted his doctor because of cramp in the arms and legs; this was followed by general lassitude, loss of appetite and colicky abdominal pain; he was referred to hospital where he was admitted for investigation. A high proportion (34,000 per million) of stippled red blood cells was found and the urinary excretion of lead in a 24-hour specimen of 1,300 c.c. was calculated to be 0·15 mgm. per litre.

White and Red Lead Works

Two cases were reported; one, aged 38, employed for six years and nine months in the manufacture of white lead, was referred by his doctor to hospital, as an outpatient, because of wrist drop due to paresis of the right extensor digitalis longus and interossei muscles; a blood examination at this time showed an anaemia with 3,950,000 red blood cells per cu.mm., haemoglobin 70 per cent and 2,000 stippled red blood cells per million. He was admitted to hospital nine days later when his urinary lead excretion was 0·26 parts per million. Shortly before his discharge, after 54 days in hospital, examination showed 4,360,000 red blood cells per cu.mm., haemoglobin 83 per cent and no punctate basophils, while the urinary lead excretion had dropped to 0·03 parts per million. Throughout he had had no abdominal symptoms. At the factory, where there were excellent washing and bathing facilities, measures were taken for the better control of lead dust and, as an additional safeguard, for the provision and use of suitable respirators.

The other case was a red lead process worker, aged 42, who had been so employed for about twelve months without previous lead exposure. Lead poisoning was suspected by his own doctor when he had been off sick previously and later support to this diagnosis was given by examination of the blood which showed anaemia and the presence of stippled cells. Conditions at the factory were good.

Vitreous Enamelling

The one reported case, aged 33, was a glass decorator for some eight years. He had been "woolling-off" excess enamel containing lead, which had been sprayed on to glass lamp-shades and other articles. To do this, he placed the articles on a revolving turntable and held a piece of cotton wool against them. The process was carried out in a cabinet with ineffective exhaust ventilation and it was necessary for him to work with his face closely over

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the job. The lead content (calculated as PbO) of the enamels varied from 49-72 per cent, but this was in a combined form as a boro-silicate of lead. The signs and symptoms in this case were headache, depression, abdominal colic, constipation, anaemia and a punctate basophil count of 12,000 per million red blood cells. The excretion of lead in the urine was reported to be 400 micrograms in 24 hours. He was successfully treated in hospital, as were two fellow-workers who showed signs of lead absorption.

Electric Accumulator Works

Eleven cases were reported (compared with 18 in 1954), three of them in an accumulator works from which cases had previously been reported. At the beginning of the year, after several breaches of the Electric Accumulator Regulations had been recognized by the firm, considerable efforts were made to effect improvements in local exhaust ventilation and to comply with the Regulations, but production continued at high pressure in restricted premises. Periodic blood examinations of all workers exposed to lead were instituted and enabled relatively early cases to be identified. Negotiations for more commodious premises were in progress.

At a small accumulator factory with only four men, a man, aged 27, was employed for 15½ months for long hours, mainly on lead burning. Localised exhaust ventilation was inadequate. Blood examination confirmed the diagnosis of lead poisoning, which was based on a history of depression and loss of energy, followed by abdominal colic and constipation.

A battery assembler, aged 23, had for a year been assembling small pasted plates and separators into steel box-jigs on a perforated metal table over a water trough, but without exhaust ventilation; he suffered from periodic and increasingly severe attacks of colicky abdominal pain with vomiting, for which he was finally admitted to hospital. He was found to have a punctate basophil count of 19,000 per million red blood cells and was successfully treated with intravenous calcium versenate.

A young man of 18 years was notified by a firm manufacturing electric accumulators as having lead poisoning, being designated as a "shop boy". Complaining of colic, vomiting and constipation, he consulted his doctor, who referred him to hospital. Previously such attacks had yielded to bed rest. The urinary lead was of the order of 46 microgrammes per 100 ml. Blood examination showed no punctate basophil red blood cells.

Paint and Colour Works

Among the six cases reported were three colour grinders in a paint factory where about a dozen men were employed; the poisoning was due in each case to exposure to lead chromate dust. In the first case, a man, aged 46, employed for seven years in the manufacture of lead chromate (including dry grinding), the main clinical findings were weakness of the extensor muscles of both wrists and paresis of the small muscles of the left hand. After return from an absence attributed to influenza, he was, at a routine medical examination, suspended from employment. The blood count was normal but punctate basophilia were present. Another man affected, aged 35, had been employed for only seven weeks, without known previous exposure to lead, when he complained of loss of appetite and colicky abdominal pain. In hospital, he was found to have a haemoglobin level of 66 per cent, with a high punctate count (30,000 per million red blood cells) and increased urinary lead excretion. The third man, aged 32, who developed abdominal colic and vomiting after six months' employment, without known previous exposure to lead, was found to have a red cell count of 3,900,000 per cu.mm., a haemoglobin level of 71 per cent and punctate basophilia of 30,000 (which fell in

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about three weeks to 5,000) per million red blood cells. This man was treated, as an outpatient, with calcium versenate. In this factory, lead chromate was made by the precipitation process, and grinding of colour was extremely dusty. Of the three chromes manufactured, the orange and lemon chromes yielded more than 5 per cent soluble lead, by the standard test. It is proposed to modernize the grinding process to give better dust control and to improve washing facilities and other amenities.

A process worker, aged 37, employed in the manufacture of colours, some with lead compounds, had two attacks of lead poisoning during the course of the year. After being employed for ten weeks, he suffered from abdominal pain and colic and was found to have punctate basophilia of 14,000 per million red blood cells. After two months' sick absence, he resumed work on grinding compounds which did not contain lead, but when a month later the blood examination was normal, he resumed contact with lead, working overtime. Two months later, he again had vague abdominal pains and punctate basophilia of 10,000 per million red blood cells. Among the compounds manufactured were lead acetate, borate, stearate and silicate. Difficulties had been experienced at this factory with the exhaust ventilation for the control of dust in the later stages of manufacture; the possibility of delivering the compounds to the main customer in paste instead of in powder form, as an additional safeguard, was being explored.

Shipbuilding

An unusual lead poisoning case was a paint-pot burner, aged 51, who had been so employed almost exclusively for eight years in a large shipyard. His job was to collect empty half-gallon paint pots, perhaps 20-30 daily, from the large number of painters employed, to make a heap of these in a remote part of the yard, to set them alight and subsequently, with a wire brush, to scour the inside of the pots to remove the charred paint residues. Red lead and paint containing white lead as a base were in use, and it was clear that a good deal of fume was evolved during the burning of the paint, but perhaps the greater lead hazard arose from the pot-scouring. He was admitted to hospital with abdominal colic, constipation, muscular weakness, pronounced blue line on his gums and loss of appetite, the diagnosis of lead poisoning being confirmed by biochemical means. After treatment by intravenous injections of calcium versenate, he made a good recovery. Pending the devising of an alternative to this method of cleaning out the paint pots, which is commonly used in shipyards in the area, it was arranged that better use would be made of the respirator provided for the work.

Paint Used in Other Industries

Two of the three cases included in this group were young persons, a boy and a girl both aged 16, employed as sprayers in different factories. The boy had been spraying priming paint containing 20 per cent of lead on to window frames, in a booth provided with exhaust ventilation which was not fully efficient. After doing this work (which is subject to special statutory provisions) for six weeks, he suffered from colicky pains and tenderness of the abdomen without constipation; on admission to hospital, blood examination showed haemoglobin 54 per cent, marked hypochromia and anisocytosis, moderate poikilocytosis and polychromasia, with a severe degree of basophilic stippling. Men, instead of young persons, are now employed on this work; periodical medical examinations have been instituted and the conditions have been improved.

After being employed for about one year in a factory in cleaning off excess paint from glass bowls, a girl, then aged 16, started spraying the bowls with

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a colour containing lead, in a booth fitted with mechanical exhaust ventilation. A certain amount of spray escaped from the booth and respirators were provided. Seven weeks after starting this work, she was admitted to hospital with severe abdominal pain, weakness and vomiting, the symptoms subsiding after three days' rest and medical treatment. Blood examination showed haemoglobin 60 per cent and punctate basophilia of 45,000 per million red blood cells. A week later a 24-hour specimen of urine (800 ml.) contained 0·02 mgm. lead. Special precautions and medical examinations are required by law where women and young persons are employed in processes involving the use of "lead compounds". These precautions were not taken in this case. The factory has since closed down.

A man, aged 40, had for twenty years been applying a lead paint primer by brush to window frames. The washing and other facilities in the factory were good. He was admitted to hospital suffering from right wrist drop; the urinary excretion of lead some few weeks later was 0·22 mgm. per litre over 24 hours. Haemoglobin was 66 per cent and there was hypochromic anaemia with punctate basophilia. He gave a history of several sick absences from work, of inability for about a year to straighten the fingers of his right hand, and of colicky abdominal pain and indigestion. After his discharge from hospital, he returned to work in the factory in a lead-free department.

Other Industries

Sixteen cases were reported from other industries, compared with five cases in 1954. Four of these were employed in lead discing of motor car bodies in a factory where previous cases had occurred. A high standard of medical supervision by full-time industrial medical officers is maintained at this factory, including regular blood examinations of all employees exposed to a lead hazard. In order to minimize the exposure to lead, experiments are being made with special exhaust appliances fitted to the discing wheels, the wearing of pressurized helmets and the enclosure, with exhaust ventilation, of discing areas. One of the men, aged 37, employed on discing for three to four months, had been using compressed air to blow off the dust from his overalls, having taken off his respirator. He had an attack of intestinal colic and was admitted to hospital, where a blood examination showed a haemoglobin level of 85 per cent, a punctate basophil count of 8,000 per million red blood cells, marked polychromasia and considerable increase in urinary output of lead.

Three cases were reported from a factory making lead compounds; one of these was a potman, aged 25, and the other two were packers of lead compounds. The potman was employed for ten weeks at a furnace into which lead was fed, lead oxide dust being drawn off into an overhead cyclone. One day, in attempting to clear a blockage in the cyclone, the potman, not wearing a respirator, got a blow-back of lead oxide into his nose and mouth. Some three weeks later he complained of pains in the stomach, nausea and vomiting, constipation and weakness of the legs. The diagnosis of lead poisoning was confirmed in hospital.

A worker, aged 37, with some previous lead exposure, employed for ten weeks on production of a metal powder containing 30 per cent lead, reported to the works nurse owing to severe abdominal pain. Subsequently, he was diagnosed as having lead poisoning with classical symptoms, and confirmatory evidence was obtained from a blood examination. In order to remove the clinker-like residues it had been necessary to enter twice weekly the chamber in which the lead-containing dust was collected, and for this purpose an air-line respirator was provided. It seemed likely that the man in question had

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entered the chamber wearing a less effective respirator; it was after this cleaning work that he was taken ill.

A metal sorter, aged 28, was engaged in a scrap-metal merchant's yard for about a year in burning, in a small works boiler, large amounts of crêpe paper contaminated with lead oxide. The paper was collected in sacks from a firm making electric accumulators and had been used to interleave the pasted plates during drying. About 8 to 10 cwt. of the ash was recovered each week and shovelled into open drums for despatch to a firm of lead smelters. The sorter suffered from colic and increasing constipation; while in hospital he was found to have a very well-marked blue line on the gums, moderate anaemia and punctate basophilia. On appreciating the risk of lead poisoning, the firm discontinued the practice of burning this paper, the paper being transported direct to the lead smelters in sealed containers.

Painting of Buildings

Two painters, employed by a firm of contractors, suffered from lead poisoning after burning off red lead paint from a heavily painted steel roof structure during a period of three or four months. After burning, the paint was scraped or brushed off. Compressed air-line breathing apparatus was not available for all exposed to lead fume. One of the burners suffered from abdominal pain, vomiting, constipation and muscular weakness, as well as punctate basophilia, while the other had similar symptoms with, in addition, a urinary lead excretion considerably in excess of normal. It was recommended that all burners should be medically examined at weekly intervals but the work was completed without further incident shortly after these cases had occurred.

PHOSPHORUS POISONING

Two cases of phosphorus poisoning, the first since 1944, were reported from a factory manufacturing phosphorus in electric furnaces from phosphatic rock. The men working on the plant are liable to be exposed to fume from the furnace and when the slag was run off, perhaps once a day, as well as at various points in the subsequent handling of phosphorus and phosphorus-containing slurry.

These cases were reported after discussions with the firm and a careful examination by an Inspector of records of periodical examinations by a dental surgeon at the factory, following the death from natural causes in 1954 of a pensioned worker who had had necrosis of the lower jaw in 1943. For over twenty years the works dental surgeon has examined men prior to employment, and thereafter at regular intervals. All men showing any evidence of necrosis of the jaw were removed from further exposure to phosphorus and not allowed to go back on to the plant. Both of the cases reported were edentulous; one, aged 54, employed for several years, had some exposure of the upper jaw bone, while the other, aged 45, employed for fifteen years, had had a small sequestrum of bone removed from the right lower jaw, following ulceration. Notification of a case of phosphorus poisoning should be made as soon as any effect of phosphorus or of its compounds is detected. Phosphorus burns of the skin are not regarded as phosphorus poisoning.

MERCURY POISONING

One of the two cases of mercury poisoning reported was a labourer, aged 66, who had for the past five years spent half his working time filling small containers with mercury. For the previous thirteen years he had been employed in handling salts of mercury, some of which may have been organic.

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An exhausted hood was fitted over the mercury trough, but he filled the bottles in the open shop. He had been medically examined regularly by the works medical officer while employed in the mercurial compounds department, but later refused to continue with this periodic examination and had only been examined once (with negative findings) while working in the mercury department. For about two years he had noticed heaviness of his arms and a feeling of "pins and needles" in arms and fingers, especially on the right side. He then found that he could not control a pen properly when writing, or his hand when trying to pick up small objects. There was slight hesitancy in his speech. His condition gradually became worse until he had to give up work. In hospital he was found to have intermittent claudication due to arteriosclerotic changes, the only abnormal findings being a marked intention tremor of the right arm and a positive Wassermann reaction. Mercury in urine was estimated at 230 micrograms per 24-hour specimen, some two to three months after all exposure to mercury had ended.

The other case was a process worker, aged 26, who had been employed for about two years in the manufacture of miscellaneous mercurial products and in handling metallic mercury. This was also an unusual case, as the diagnosis was complicated by epilepsy, for which he had been taking phenobarbitone and epanutin three times a day since the condition was diagnosed four years before. He became irritable over trivial matters, short-tempered with his wife and family, depressed, lost interest in his home and even contemplated suicide. The works medical officer whom he consulted arranged his admission to hospital. Due to his epilepsy, he was potentially emotionally unstable, but these symptoms appeared to worsen while he was working with mercurial preparations. The hospital physician found that for some considerable time he had been excreting more than 500 micrograms of mercury in his urine and had also appreciable amounts in the cerebro-spinal fluid. In view of this finding, together with certain emotional changes, tremor and some degree of stomatitis, the physician felt justified in diagnosing mercurial poisoning. This diagnosis was supported by his very considerable improvement after treatment instituted with a view to depleting him of mercury.

Carbon Bisulphide Poisoning

One slight case of carbon bisulphide poisoning in a process worker, aged 54, employed by a firm of manufacturing chemists, was notified. The process was the manufacture of a veterinary medicine involving the use of carbon bisulphide. The carbon bisulphide was run into an open reaction vessel with other materials and the product run off into a filter from which it was finally removed by hand implements into a barrow, for transference to the main factory for drying and packing.

A mask with a tube to the fresh air was provided, but on this occasion was only used when emptying the filter, not while charging it or during the reaction. During transference of the filtered material, a dust respirator was worn. As the process was unpleasant it was carried out on a rota system, each man transferring the filtered material for two hours and for the remainder of the shift attending to the reaction vessel. The same evening one of the men had a headache, felt dizzy and later started vomiting, which continued all night. The following day he felt better but very shaken. A full-time works doctor carries out regular periodical medical examinations at this works.

Aniline Poisoning ("Anilism")

Nine cases were reported during the year, four of them from the same firm of chemical manufacturers. A process worker, aged 40, suffered from severe cyanosis, nausea and vertigo after running off para-toluidine in liquid form

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into a series of open trays in a special room. He stated that he was wearing the respirator provided and gloves. Another process worker, aged 27, was also affected by fumes of para-toluidine while running the chemical into a portable drum from a heated tank, without wearing the respirator provided. He was detained in hospital for twenty-four hours, suffering from headache, vertigo and cyanosis. One case at this works was caused by molten para-chloraniline running on to his sleeve during the charging of a still with the molten chemical out of a drum. He was wearing a respirator and gloves. The symptoms were headache, nausea, vertigo and deep cyanosis, for which he was treated in hospital for two days. The remaining case, a fitter, doing many jobs, was due to an unidentified nitro or amino benzene derivative, possibly paranitrochlorbenzene. His foreman noticed that he was looking ill, and sent him to the works doctor; he was off sick a few days with cyanosis, shortness of breath, weakness and vertigo.

One case due to dinitrotoluene was rather atypical. A process worker, aged 54, and a workmate had been employed emptying crystals of DNT from crystallization trays into a large tray from which they were bagged and put through a hydro-extractor and packed into casks. The day was extremely hot and owing to pressure of work they worked longer hours than usual. He did not work the following day, a Saturday, but after drinking a pint of beer at his club that evening he felt dizzy, nauseated and collapsed. When admitted to hospital he was found to be cyanosed. His workmate had felt sick and had vomited at home on the night the work was done but had had no further symptoms.

A maintenance fitter was heavily splashed with orthotoluidine while fitting a new gland packing and went for a bath and change of clothing but returned to work wearing the same boots. He very soon became deeply cyanosed. This is an illustration of the necessity of a complete change of clothing, as well as a bath, in circumstances such as this.

Chronic Benzene Poisoning

A fatal case, believed to be delayed chronic benzol poisoning, was a man, aged 41, who had been a french polisher for twenty-six years, with a break for war service during which he suffered from malaria. For the first nineteen years of his employment he had occasionally used a paint stripper containing upwards of 60 per cent of benzol, but exposure to benzol had ceased five years before symptoms developed, as during this time he had used a benzene-free stripper containing mostly methylene chloride. He first complained of haemorrhoids with fairly frequent bleeding, and then suffered from pains in the head and general weakness and dizziness, especially in the morning. About six months after the onset of these symptoms, petechiae and occasional ecchymoses were noted. As treatment for the haemorrhoids by injection was unsuccessful, it was decided to ligate them, but before this was done he was found to be suffering from anaemia and leucopenia. At this time, blood examination showed red blood cells 2,710,000 per c.mm., haemoglobin 40 per cent, with the cells showing some anisocytosis, reticulocytes 1 per cent, white blood cells 2,000 per c.mm. and platelets 70,000, the anaemia being described as aplastic. After transfusions daily for twelve days, his haemoglobin had risen to 52 per cent. Enlargement of the spleen was first noticed 3½ months before he died. A smear from the sternal bone marrow showed extensive hypoplasia. Blood transfusions were continued, together with injections of cortisone, but the anaemia and leucopenia remained, the blood platelets numbering only 25,000 at one time. Despite this treatment, his condition steadily became worse and he died of pneumonia just under five months after

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his blood condition had been recognized. On the day before his death, the haemoglobin was 20 per cent, white blood cells 3,700 per c.mm., and X-ray examination showed consolidation of the upper half of the upper lobe of the left lung; his temperature was 104°F. and penicillin and streptomycin were of no avail. This case was notified by the hospital as "toxic anaemia", which led to investigation of his occupational history and discovery of his long exposure to benzol. This points to the value of this alternative method of notification of anaemia, which invites a meticulous investigation into possible occupational causative factors.

Toxic Anaemia

The four notifications of toxic anaemia, three men and one woman, followed an investigation at an aircraft factory. During an inspection of this factory some time before the cases were notified, it was found that a solution containing, among other ingredients, benzene, was being used in adhesives applied by brush and subsequently dried in ovens, from which a considerable amount of vapour escaped. At this time the firm agreed to examine the possibility of substituting another solvent for benzene (as was done later) and to instal local exhaust ventilation at the spreading tables and ovens. Periodical medical examinations were made by the Works Doctor and the notifications followed blood examinations by a Medical Inspector. Of the eight employed on this work and examined eleven months previously by the Medical Inspector, five showed a further fall in the red blood cell counts, while of eight others not previously examined four showed some degree of anaemia. These early slight indications of absorption of a toxic chemical, in spite of unequivocal exposure to benzene, were pursued. It was thought that aniline amongst the other solvents used might also have been a factor. This view was supported in that there was a subsequent marked improvement in the blood pictures of operatives who were removed from the work, while two men who had used almost exclusively the aniline-containing adhesive continued to show a low colour-index anaemia. Their hands and overalls were heavily coated with adhesive. The firm is now fully alive to the hazards to health involved in this work.

Anthrax

There was no death among the 15 cases reported during the year and this number was the lowest reported in any year since 1946, when there were 14 cases, including one fatality. Five cases were in contact with wool, five with hides and skins, while the remaining five occurred in other industries.

Wool

One of the cases in this group was a mechanic, aged 56, employed in the preparing department of a wool spinning mill. During meal-times, he often worked a willeying machine while the operator was out of the department. While shaving on a Saturday morning he cut himself; he later worked in the factory, dry sweeping and brushing. The following Monday he worked as usual, but during the night his chin was sore where he had cut himself, and he felt shivery. The next day he left the factory at mid-morning to see his doctor, and attended his doctor again in the evening, feeling shivery and thinking he had influenza, his chin being sore and swollen at this time. On the following day, Wednesday, he felt worse and his doctor visited him at home. The managing director telephoned to the doctor in the evening to inform him of the nature of the patient's work and of the possible risk of anthrax. On admission to hospital next morning, there was a large swelling

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on the chin with a black eschar, surrounding pustules, erythema and very marked oedema. A provisional diagnosis of anthrax was made on the appearance of the lesion, and treatment by intramuscular penicillin was started immediately. Bacteriological examination by smear and culture was negative, probably owing to previous initial treatment by penicillin cream for two days. There seemed to be little doubt that this infection arose at work, probably from contact with East Indian wool.

Another case in which bacteriological examination was negative for anthrax (but positive for haemolytic staphylococci) although the lesion was a typical malignant pustule, was a woman, aged 47, employed as a doubler in a carpet yarn factory where a blend of East Indian wool fleece and British cowhair was used. After treating what she thought was a boil on the left forearm with fomentations for five days, she visited her doctor who sent her to hospital. Treatment in this case was with penicillin and streptomycin.

A wool blender, aged 48, reported to his doctor with a painful pimple in the left submaxillary region. The doctor, diagnosing malignant pustule, sent him to hospital where this diagnosis was confirmed bacteriologically. This man kept a few cows on a smallholding but these, when examined by a veterinary surgeon, were found to be healthy. His shaving brush, razor, face cloth and towel were also examined bacteriologically for bacillus anthracis with negative results. The only item of unwashed material passing through the blending department of the factory at the relevant time was a piebald hair ("caracal wool") from South Africa and this was thought to be the source of his infection.

Hides and Skins

Of the five cases in this group, two, which occurred in different parts of the country, were infected by material from the same cargo of hides and skins.

Two days after a winch driver, aged 44, in the docks had completed the unloading of a consignment of dried salted hides and goat and sheep skins from Nigeria, he reported to the medical centre with a small "insect bite" at the upper end of his breastbone. Two days later, he was admitted to hospital with a high temperature, severe headache, shivering and a very large typical anthrax pustule at the upper end of the breastbone, around which was a very pronounced local reaction. He was treated first with penicillin, which was not satisfactory in this case, and then with aureomycin. The diagnosis was confirmed bacteriologically, a virulent strain of anthrax being isolated.

When the case just described occurred, all consignees of the hides and skins in this cargo were informed by the Factory Department, as is the practice in such circumstances. Among them was a firm of leather manufacturers. The manager of this firm immediately warned his workers and as a result one man reported a spot on his arm and was promptly sent to hospital by the Appointed Factory Doctor. This man was a lime shop chargehand, aged 28, who had assisted in the unloading of the particular consignment of hides and skins from road lorries. A small pimple appeared on his right forearm two days later and this developed into a characteristic malignant pustule, but on his admission to hospital he was afebrile. A smear was positive for anthrax bacilli, and treatment with penicillin intramuscularly proved rapidly successful. The firm were advised to process the skins as quickly as possible and this was done during the following week, the men

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handling them having a daily inspection of the skin. No further cases occurred.

The other three cases in this group, all confirmed bacteriologically, were tannery workers, the lesions being situated on the finger, eyebrow and neck, and the treatment consisting of anti-anthrax serum, serum with penicillin, and penicillin respectively.

Other Industries

All the cases in this group were of moderate severity, and all were reported from glue and gelatine factories, four from one factory and one from another. In both these factories, previous cases had occurred from anthrax-infected dried Indian bones and each factory had made good arrangements with a local hospital for the immediate examination of suspected cases, in order that any treatment necessary might be given without delay. The four cases in the first factory were labourers who had been exposed to dust while carrying or emptying sacks of bones, sorting empty sacks and sweeping up spilled bones. Dust extraction was provided in the dry bone warehouse, but, despite damping, some dust arose while handling sacks from railway wagons and in sweeping floors. Two of the lesions occurred on the right side of the forehead, one on the left ear and one on the left side of the neck. Each case was treated with penicillin with, in one case, aureomycin in addition.

The case at the other glue and gelatine factory was a chargehand, aged 42, who was most meticulous about any suspected anthrax case and always took energetic steps to warn men working under him of this hazard. After having been away from work for about twelve days, he visited the factory to collect his pay and complained of a stiff neck to the foreman, who advised him to see his doctor. Two days later he was admitted to hospital with a small malignant pustule on the lobe of the left ear, extensive involvement of the left cervical glands and periglandular oedema. His temperature was 102·4°F. and he was in a toxic condition. It would seem that this man must have been infected from spores which he had been carrying on his clothing.

EPITHELIOMATOUS ULCERATION

Cases classified as epitheliomatous ulceration in Table 26 include fatal and non-fatal cases notified under Section 66 of the Factories Act, 1937, and also cases resulting from a scrutiny of copies of death certificates supplied by the Registrar General which are subsequently investigated by the Factory Department as to the occupational history. Among the latter will be some that have been notified during life; these are included in the Table as deaths only, but the remainder are recorded as cases and deaths.

In some instances, mainly those of persons suffering from pitch or tar warts, the same worker was notified as a case on more than one occasion during the year. Two men were so notified four times; two, three times and eleven men twice. Different sites were involved except in two instances, in each of which a recurrence had occurred at the site of previous treatment.

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TABLE 27

NATURE OF TREATMENT GIVEN FOR EPITHELIOMATOUS ULCERATION

	Nature of Treatment						
	Excision	X-Ray	Cauterization Diathermy	Radium	CO_2 "Snow"	Not stated	Total
PITCH AND TAR							
Gas manufacture ..	8	8	1	1	1	7	26
Tar distillation ..	11	34	11	3	—	12	71
Coke Ovens	6	—	—	—	—	4	10
Patent fuel manufacture	7	5	14	1	—	18	45
Other industries ..	6	4	—	1	—	—	11
MINERAL OIL							
Cotton spinners ..	29	—	—	1	—	10	40
Other occupations ..	5	—	—	1	—	2	8
Total	72	51	26	8	1	53	211

Table 27 shows that the nature of the treatment given was recorded for three-quarters (158) of the cases notified and that nearly one half (72) of these were treated by excision. The nature of the treatment depends on a number of factors, including the stage the disease has reached and, to some extent, the facilities available locally. In one tar distillation works, treatment was mainly by diathermy, while in another similar works in another part of the country most of the cases of pitch warts, in an early stage, were treated by a single irradiation by low-voltage X-rays.

Early recognition of suspected cases is of the greatest importance and is best achieved by careful medical supervision with periodical medical examinations.

Pitch and Tar

Exposure to pitch and tar caused 163 cases, with five deaths. A pitch loader, aged 53, who had been exposed to pitch dust while breaking up and shovelling pitch for five years, first noticed the condition on holiday, and on return to work was found at a routine medical examination to have several warty growths, some of which had ulcerated, on the scrotum, with secondary infection of the inguinal glands. This man is said to have used the excellent washing and shower-bath facilities provided but he wore his contaminated clothing continuously throughout his employment on different jobs, some of which did not involve contact with pitch. Moreover, his clothing was said "never to be washed". This would have been an important contributory factor in producing so severe a condition in a comparatively short time. This man had not previously worked with pitch and, other than on the scrotum, had no skin lesions.

A radiotherapist, reporting on a naphthalene plant attendant, aged 57, employed in a tar distillery for fourteen years said that, in addition to a recurrence of a previously treated epithelioma on the dorsum of the right hand, this man had had six skin carcinomata treated by X-ray therapy. Over the past few months he had complained of numbness in both hands and, at hospital, some paraesthesia was detected for which a cause could not be suggested.

A carpenter, aged 44, developed a small pitch wart on the left side of his neck after working for a long-term contractor at a gas works for nine years. He had worked for some time below a gantry along which pitch wagons passed from time to time. The wart was excised six weeks after X-ray treatment, as it was increasing in size; pathologically, it was confirmed to be a squamous-celled carcinoma.

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The five fatal cases attributed to pitch and tar were as follows:

Nature of occupation	*Duration in years*	*Age at death*	*Recorded cause of death*
Gas works retort house worker	31	74	Fungating carcinoma of cervical glands, primary in lower lip.
Gas works labourer	24	64	Carcinoma of neck and of lower lip.
Gas works fireman	54	77	Carcinoma of pelvis and scrotum.
Tar stillman	55	87	Epitheliomatous ulcer of neck.
Coke oven worker	28	57	Cancer of scrotum with metastases in inguinal glands.

Mineral Oil

Forty-eight cases, with 9 deaths, were notified, of which 40 cases, with 7 fatalities, were cotton spinners and 8 cases, with 2 fatalities, were in other industries. In addition to these notifications, information was received during the year as to 4 deaths, 2 cotton spinners and 2 in other occupations, which had been reported as cases previously. Table 26, therefore, records for mineral oil 48 cases and 13 deaths.

The scrotum was the site of the lesion in 29 of the 42 cotton workers and in 4 out of 10 in other industries.

In the Annual Report for 1954 it was recorded (p. 188) that the site of a lesion in a fatal case (a cotton spinner) had not been identified. Information has now been received that this was a rodent ulcer on the right side of the nose at the level of the inner canthus of the eye.

A man employed in a mule spinning department as a minder's assistant for five years had never availed himself of the voluntary periodical medical examinations provided by his firm; he retired at the age of 65, one month before the statutory examinations were instituted. Shortly after retirement he noticed a "pimple" on the scrotum but it was eleven months before he consulted his doctor; a large fungating growth considered to be beyond treatment was found. In some organizations, retired workers who have been at risk are examined periodically and this practice is highly commendable.

An assistant mule spinner, aged 56, with forty-two years' employment, was in hospital being prepared for an inguinal hernia operation when an epithelioma of the scrotum was noticed. This was removed in the course of the operation and was found to be an early, very well differentiated squamous carcinoma. The statutory medical examination of mule spinners had just started at this mill and the spinner had already gone off work when the doctor visited to carry out his first series of examinations.

A woman, aged 79, who had retired for twenty-four years after forty-two years' employment as a frame tenter in a cotton mill, was referred to hospital when she was found to have "several small areas of rodent ulceration on the left outer canthus, but well clear of the eye, and also a keratotic lesion of the right wrist". Histological examination of the wrist lesion was suggestive of skin cancer.

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The occupations (excluding those in the cotton industry), durations of exposure to mineral oil, sites of lesion and ages of the ten cases, including two cases recorded in Table 26 as death only, were as follows:

Nature of occupation	*Duration of occupation in years*	*Age*	*Site of lesion*
Automatic machine tool setter	30	45	Right forearm.
Automatic machine tool setter	21	37	Right wrist.
Automatic machine tool setter	20	75	Scrotum, with extensive secondaries (fatal).
Automatic machine tool setter	17	34	Scrotum, with extensive secondaries. (Recorded as death only.)
Capstan lathe operator	33	54	Scrotum. Secondary carcinoma of lung. (Recorded as death only.)
Automatic machine tool setter	40	63	Left hand.
Making oil gas from shale oil	33	59	Left middle finger.
Gear cutter	45	61	Scrotum, with extensive secondaries (fatal).
Jute spinner (female)	60	83	Right forearm, with old-standing dermatitis of both forearms.
Feeder (female) at breaker card (jute)	41	56	Left forearm.

In the corresponding table (p. 189) in the Annual Report for 1954, the occupation of one man was described as "oiling jute for 23 years". This man had in fact been a jute worker for twenty-three years but had been an oiler of machinery in the spinning department for seven years, and thereafter foreman of that department except for a break of three years.

The woman recorded above, aged 56, had been employed in a jute works as a feeder at a breaker card for forty-one years, when she ceased work for reasons unconnected with health. A year later she received treatment for a lesion of the left forearm, which had been present for "a year or two" and which she thought at first to be an ordinary boil. After it had increased in size and ulcerated, it was excised and proved to be a squamous-celled epithelioma. The raw jute, before being brought to the breaker cards, had been treated with an emulsion containing approximately 11¼ per cent mineral oil and 0·5 per cent whale oil in water. It was estimated that each breaker card operator would, in a week, handle jute treated with some 66 gallons of mineral oil. In this case it would appear that the etiological agent was present in the batching emulsion.

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The precise relationship between basal-celled carcinoma (rodent ulcer) and exposure to carcinogenic agents such as mineral oil and coal tar products is of considerable interest. A number of practitioners have notified cases of rodent ulcer to this Department in the belief that they were occupational in origin; in some cases the evidence seemed to be satisfying and therefore such cases are included in the annual figures for "epitheliomatous ulceration" due to the specified agents. It is proposed to explore further the information available in the Department with regard to basal-celled carcinoma and the results will be submitted in a future report.

Carcinoma of the Scrotum in a Chimney Sweep

During the course of enquiries into notifiable cases of epitheliomatous ulceration, the death of a chimney sweep, aged 65, from carcinoma of the scrotum came to light. Although this occupation is not classified as factory employment the case is included here because his occupational and clinical history had many points of interest. Except for a short period during the last war he had worked full time as a chimney sweep, as had his father and grandfather, for over forty years. He had had no bathroom in his former house and had not been in the habit of changing his clothes after work. Three years before his admission to hospital he had cut off with scissors two small warts which had been present on the left side of his scrotum for about one year. Since that time the area had been continually septic, the inferior aspect of the scrotum had sloughed away, and the inguinal glands had enlarged. Histological examination after extensive excision showed the tumour to be a well differentiated squamous cell carcinoma, the metastatic deposits in several lymph glands examined being of similar character. X-ray treatment was carried out before his discharge from hospital, but he was re-admitted about six months later with extensive sloughing in the symphysis pubis and secondary deposits in the lungs. He died about thirteen months after his first admission to hospital.

The tumour must have been of low malignancy as it had been noticed by the deceased about five years before his death. There had been little regard for cleanliness and the case is a sad reflection on the attitude of the public to early diagnosis and treatment. Medical treatment was sought only when the case was unbelievably far advanced and when cachexia had been present for about six months. The deceased's surgical treatment of himself was also an extraordinary feature.

CHROME ULCERATION

Two hundred and sixty-one cases of chrome ulceration were reported, compared with 220 in the previous year. The numbers of bichromate and chromium plating workers reported were similar to those in 1954, but cases classified under other industries totalled 55 compared with 17 in the previous year, this increase being mainly due to outbreaks of nasal ulceration at two factories, in one of which 32 cases occurred and in another 12 cases. Two hundred and twenty-one cases were males, 35 females, and 5 cases, four male and one female, employed on chromium plating, were young persons. Eight males were reported on two occasions during the year.

One hundred and four cases occurred in the bichromate manufacturing industry. In one factory the shortness of the duration of exposure to chrome compounds was of interest, being in the following two cases less than a fortnight. A man, who was employed by a firm of weighing machine makers in maintaining their many scales and weighing machines in the chemical works, contracted severe multiple ulcers of the hands and fingers during four days'

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work. An employee of the chemical firm, removing bogies of sodium bichromate from the drier and packing it into drums, developed multiple ulcers of the hands and ulceration of both sides of the nasal septum in a period of ten days.

Another case was a labourer, aged 21, who was employed for one month in handling bichromate of sodium in the crystal house. He developed multiple ulcers distributed on the inner malleolus of the right ankle, above right heel, left ankle, dorsum of right foot, right forefinger and left hand. The ulcers on his legs were due to carelessness in allowing crystals to enter his protective footwear while shovelling.

During the year this firm made improvements to machinery and methods of dust and fume removal, and increased the medical supervision to include all workers, not only those under the Chemical Works Regulations, 1922. A consultant physician was also appointed, who visits the factory each quarter. It is possible that the slight increase in the number of notifications resulted from this intensified supervision.

Among the cases reported from another bichromate factory was one who had been employed for only four days and another who had been employed for less than two weeks. In this factory nearly half the cases occurred during the process of granulating bichromate and running the crystals into steel drums.

The 102 chromium plating cases reported included 88 males, 9 females, 4 male young persons and 1 female young person, one of the males being reported as a case on two occasions. Ten of these cases, eight males and two females, were reported by a firm engaged on the chromium plating of small articles during day and night shifts. The outbreak was sudden, as all the workers had been examined by the Appointed Factory Doctor at his previous visit, when no lesions were present. At his next visit a fortnight later, however, the Appointed Factory Doctor found it necessary to suspend seventeen chromium plating workers, ten of these being subsequently confirmed as cases of chrome ulceration. The site of the ulceration was the nose in each case, and prominent features were sneezing, epistaxis and headache. Anemometer readings showed that the exhaust at the chromium plating vat was defective, due to a damaged fan in the ducting. It was thought that this fan had been damaged by falling roof slates during the installation of new ducting.

An unusual case in this group was a woman, aged 26, who after about eight months' employment in an electro-plating factory was obliged to stay in bed owing to a heart condition. Suffering from nasal catarrh, she suspected that this might be the result of chrome ulceration, and about a year after leaving her employment she detected, by means of a mirror, a perforation of her nasal septum.

In 48 of the 55 cases included under other industries the lesion was in the nose. Thirty-two cases, in all of which the nasal septum was affected, occurred at a factory manufacturing textile machinery and resulted from the inhalation of dust containing potassium bichromate deposited by fall-out from steam arising from a tank containing a near-boiling solution of ammonium and potassium bichromates used for chromating metal parts. A further twelve cases of nasal ulceration, which occurred at another factory, arose from the immersion of zinc articles in a cold passivating solution containing potassium bichromate. The forty-four cases of nasal ulceration at these two factories illustrate the risk of handling chrome solutions in any circumstances,

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even where no Special Regulations apply. Following these instances, effective measures were taken to prevent the inhalation of chromic acid or chromate mists, and periodic medical examination was introduced.

One case in this group was a printer's assistant, aged 50, who had been employed on a process in which zinc and white metal alloy sheets were placed in a shaker, the sheets then being covered with steel marbles and a solution of sodium bichromate. The apparatus was then agitated, the machine tilted to allow the solution to be drained off, and the plate washed and scrubbed. During this process a marble sometimes fell into the trough used for containing the sodium bichromate solution and the printer's assistant had been in the habit of retrieving these marbles by immersing his arms in the solution up to elbow level. His main affection was a weeping eczematous rash involving the hands and forearms, back and neck, and around the eyes. Originally thought to be endogenous in character and having been resistant to nine months of treatment, its true nature was not established until a dermatologist to whom the patient was referred made enquiry into his occupation. A skin test then made with sodium bichromate revealed sensitisation to that chemical. In addition, there were small chrome ulcers on the left ring and right little fingers, the ulcers by themselves being of little significance compared with the dermatitis, but making the case reportable.

Suspected Cyanide Poisoning

A suspected case of cyanide poisoning was reported in a male electroplater, aged 51, who, while immersing some components in a cadmium plating vat, accidentally splashed his lips with an alkaline cyanide solution from which cadmium salts were deposited, and then wiped his mouth with his hand. Soon afterwards he felt faint and sick and was taken to the ambulance room where he was given the recommended cyanide antidote, thereafter being transferred to hospital and detained overnight. On admission to hospital, he complained of considerable epigastric pain, had rapid respiration and was thought to be of a very neurotic temperament. The solution in the vat contained about 3 to 4 oz. of cadmium cyanide salts per gallon, about 3 to 4 per cent strength, and the amount of liquid likely to have been ingested must have been quite small. A fatal case of poisoning has been recorded from the ingestion of five grains of cyanide of potassium, an amount which would be present in approximately half an ounce of the liquid. In this case it is hardly conceivable that any more than a very small proportion of this amount of solution could have been ingested accidentally but the symptoms, particularly the hurried respiration, were not incompatible with cyanide poisoning.

Toluylene Diisocyanate — Chest and Skin Manifestations

During the year, information was received about two cases of asthma and one of dermatitis following exposure to the fumes of toluylene diisocyanate during its use in the manufacture of a synthetic spongy material. After carrying out cleaning operations on the process for about ten days, one of the men suffered from a very severe asthmatic attack which his doctor relieved with morphia. The following day a blister appeared on his face and one month after the attack he still complained of tightness of his chest. The reason for his attack was obscure but was thought to be due to fumes from some material left in one of the tubes being cleaned. Another case was a joiner who, during a period of two weeks while erecting partitioning in a room where a machine for the manufacture of the spongy material was undergoing tests, complained of difficulty in breathing, especially in bed at night. About five months later, while working on a Saturday morning above the machine which was stopped, he noticed a strong smell. After about half-an-hour he

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found he could not breathe or stand up and was taken to a doctor, who found him to be suffering from a remarkably severe asthmatic attack which cleared up rapidly with adrenalin. The third case was a man who worked on the process for five months and then developed a rash on his face, hands and arms which was so severe as to require treatment in bed for two weeks.

Compressed Air Illness

Eight cases were notified. Seven of these, including one fatality, occurred in the first five months of the year during the completion of a river tunnel. In addition to these cases, there were a number of minor ones in which decompression was carried out because of complaints of bends, but no time was lost. Consideration is being given to standards of reportability in such cases.

The fatal case was a caulker's labourer, aged 50, but prior to engagement he had given his age as 41 and stated that he had had some experience some ten years previously of working at a pressure of 30 lb. After being certified as medically fit, he did a half shift of only three hours, at 33 lb. pressure, as was usual with all new workers. He worked well, and apparently without ill effect. The next day he completed a full shift of six hours at 33 lb., decompression at the end of the shift lasting 112 minutes. About 15 minutes before decompression was completed and when the pressure had been reduced to approximately 1½ lb., he complained of pain in his knees and was advised to walk about, which he did. After this he sat, and then lay down. On the completion of decompression, however, he was found to be unconscious and was taken to the medical lock, which was being held in readiness, as the chargehand had telephoned from the decompression lock at the onset of this man's symptoms. The works' doctor arrived about ten minutes later, by which time the patient had been recompressed and regained consciousness. He complained of very severe pain in the stomach and in the ears. He was kept in the medical lock for 10½ hours, when recompression, followed by decompression, was completed; soon after leaving he complained of stomach pain, and the doctor was recalled. He was found to be suffering from severe colic, pallor, cold moist skin and a rapid pulse, and, as when first seen, the possibility of an acute abdominal condition was considered. Shortly afterwards he appeared to improve but the doctor decided to keep him overnight at normal pressure in the medical lock, where he could be made comfortable and kept under observation. He slept fitfully during the night but a change in his condition was noticed early next morning. The doctor was summoned immediately, but on arrival found him to be dead. At the post-mortem examination a small collection of air bubbles was found in the deep subcutaneous tissues over the sternum and there was marked oedema of the tissues of the upper chest wall and neck; there were many small haemorrhages in the subcutaneous fat, the mesentery, inner aspect of the abdominal wall, and a few in the bowel; no ulceration was found in the stomach which showed in the fundus petechial haemorrhages; there was much congestion and oedema of the lungs with a few petechial and slightly larger haemorrhages. Air was found in the right pulmonary artery and in the right jugular vein. There was atheroma of the aorta and of the coronary artery. The heart muscle was pale and on microscopical examination showed considerable fatty infiltration and marked interstitial fibrosis in some areas. The brain appeared normal except for superficial oedema, but microscopically the cortex showed well-marked vacuolation. There appeared to be two factors causing death — compressed air illness and myocardial disease.

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PNEUMOCONIOSIS

The usual tables have been brought up to date and are set out below.

TABLE 28

FATAL CASES INVESTIGATED UP TO THE END OF 1955

	Number of deaths	Average age at death	Duration of employment in years		
			Longest	Shortest	Average
SILICOSIS					
Pottery:—					
Silicosis	812	61·9	65·0	2·8	38·3
Silicosis with Tuberculosis ...	533	56·2	67·0	5·0	34·7
Sandstone:—					
Silicosis	292	61·5	62·0	9·0	38·9
Silicosis with Tuberculosis...	233	57·6	61·0	5·0	37·5
Grinding of Metals:—					
Silicosis	127	59·7	61·0	14·0	36·0
Silicosis with Tuberculosis...	214	54·1	56·0	2·8	33·0
Sandblasting:—					
Silicosis	82	51·3	42·0	1·7	14·0
Silicosis with Tuberculosis...	100	46·2	46·0	2·0	13·1
Manufacture of scouring powders:—					
Silicosis	16	40·8	37·0	2·3	8·3
Silicosis with Tuberculosis...	6	40·8	11·2	2·0	7·0
Miscellaneous:—					
Silicosis	343	55·9	57·0	1·5	25·2
Silicosis with Tuberculosis...	288	52·2	50·0	0·7	25·3
TOTAL:—					
Silicosis	1,672	59·7	65·0	1·5	34·1
Silicosis with Tuberculosis...	1,374	54·5	67·0	0·7	31·2
ASBESTOS					
Asbestosis	257	50·2	48·0	0·5	16·6
Asbestosis with Tuberculosis...	89	40·5	33·0	0·8	11·4

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TABLE 29

DEATH CERTIFICATES RECORDING FIBROSIS OF THE LUNGS, INCLUDING ALL FORMS OF PNEUMOCONIOSIS, AND BYSSINOSIS

	England and Wales, 1947—1952						England and Wales			Scotland		
	1947	1948	1949	1950	1951	1952	1953	1954	1955	1953	1954	1955
							Pneumoconiosis					
SILICOSIS:—												
1. Refractories industries ..	10	13	13	8	8	11	6	16	14	3	2	3
2. Pottery, manufacture of ..	54	48	63	73	62	70	79	62	76	—	2	1
3. Sandstone, quarrying and dressing	12	28	15	10	33	9	23	16	16	—	2	2
4. Stone masons	43	40	36	19	38	23	21	22	26	1	7	4
5. Metal grinding	9	8	14	8	12	14	15	5	8	—	—	—
6. Sandblasting	5	5	5	3	3	1	3	4	12	—	—	—
7. Steel dressing and cleaning of castings	13	13	18	11	6	11	10	19	18	8	6	6
8. Stone, pebble, flint and sand crushing	3	1	3	3	1	2	4	5	4	—	—	—
9. Scouring powders, manufacture of	—	—	1	1	1	1	—	—	—	—	—	—
10. Abrasive wheel manufacture ..	—	—	—	—	2	—	1	1	2	—	—	—
11. Glass cutting and bevelling ..	—	—	—	—	—	1	1	—	—	—	—	—
12. Millstone dressing	—	—	—	1	—	1	—	—	—	—	—	—
13. Slate quarrying and dressing ..	20	16	21	17	32	35	36	40	41	1	—	—
14. Granite quarrying and dressing	4	1	1	3	3	9	8	5	2	7	6	2
15. Tunnel mining (sewage works, etc.)	—	3	2	—	2	1	1	1	—	2	2	2
16. Coal mining	347	322	336	337	347	339	1,016	1,148	1,301	240	281	323
17. Gold mining (South Africa) ..	5	4	4	6	2	2	2	—	—	—	—	—
18. Tin mining	12	11	20	9	4	17	18	30	22	—	—	—
19. Iron ore (haematite) mining ..	6	12	9	6	5	9	23	10	17	—	—	—
20. Lead mining	2	—	1	—	1	1	2	—	3	1	—	—
21. Copper mining	—	—	1	—	—	—	—	1	1	—	—	—
22. Barytes mining	1	—	3	—	1	—	—	1	1	1	—	—
23. Clay mining	—	—	1	1	—	1	—	3	2	—	1	1
24. Mining engineers	1	2	1	—	—	—	—	—	—	—	—	—
25. Miscellaneous	11	7	7	39	67	28	63	54	82	16	9	17
Total	558	534	575	555	631	586	1,332	1,443	1,648	280	318	361
ASBESTOSIS	15	15	17	12	18	12	14	12	21	1	—	—
PNEUMOCONIOSIS :—												
Coal mining	230	317	420	509	590	573	—	—	—	—	—	—
Other industries	12	19	14	26	58	44	—	—	—	—	—	—
BYSSINOSIS	4	8	7	11	8	13	22	20	35	—	—	—
OTHER CASES OF FIBROSIS	616	651	554	679	732	677	687	610	672	16	20	26
GRAND TOTAL	1,435	1,544	1,587	1,792	2,037	1,905	2,055	2,085	2,376	297	338	387

The above figures are based on information contained in Death Certificates as notified to the Registrar General.
The figures for Scotland relate to males only..

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Asbestosis and Cancer of the Lung

In the Report for 1954, analyses were made by age and duration of exposure of 205 male and 139 female deaths during the years 1924 to 1954 inclusive, which were either caused by asbestosis or in which asbestosis had been proved at autopsy.

During 1955 a further 21 such cases came to light. Cancer of the lung was present in 10 of the 17 male cases and in 3 of the 4 female cases. In no case was tuberculosis recorded in addition to asbestosis.

The additional cases do not as yet justify a repetition of the full analyses by age and duration of exposure carried out last year, but Table 30 below shows the number and percentage of the 365 cases to the end of 1955 in which asbestosis alone, or asbestosis with tuberculosis, or with cancer of the lung was present.

TABLE 30

ASBESTOSIS: DEATHS RECORDED FROM MARCH, 1924—DECEMBER, 1955

Diagnosis	Male		Female		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Asbestosis	127	57·2	85	59·4	212	58·1
Asbestosis and Pulmonary Tuberculosis	47	21·2	41	28·7	88	24·1
Asbestosis and Cancer of the Lung	48	21·6	17	11·9	65	17·8
Total	222	100·0	143	100·0	365	100·0

Note: 4 male and 8 female cases also had cancer of sites other than the lung and are included under "Asbestosis".

The proportion of all cases with cancer of the lung was 17·8 per cent compared with 13·2 per cent and 16·0 per cent in the cases which had come to light by 1947 and 1954 respectively. This proportion for males and females was 21·6 per cent and 11·9 per cent compared with 20·0 per cent and 10·1 per cent in the 1954 analysis.

Death from Beryllium Granulomatosis and Silicosis

A fatal case of beryllium granulomatosis and silicosis came to light during the year in a man, aged 41, who for five years before his death had been in receipt of a 100 per cent pneumoconiosis disability pension. He had been engaged at intervals for at least six years in the grinding of silica gel under dusty conditions and for four years had worked in a room where fluorescent lamp powder containing beryllium was manufactured. Post-mortem examination showed that in addition to terminal congestion and pneumonia there were nodules characterized by large mononuclear cells, lymphocytes and occasional giant cells. Within these nodules there were crystals having the general characteristics of cristobalite, and near the nodules there were purple staining amorphous deposits. Similar structures appeared in the hilar lymph glands. There were also small but definite whorled silicotic nodules. Analysis of the lung ash showed 0·22 per cent of silicon dioxide of the dry weight of the lung but no beryllium. In general, the picture was a combination of beryllium granulomatosis and silicosis.

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Luminisers

Examinations were carried out on 136 luminisers (112 female and 24 male) and 9 cleaners at thirty-four factories during the year. On the whole, the general health of these workers was satisfactory and any abnormalities found in the blood picture were relatively slight in character. Immature cells, usually of the nature of primitive monocytes but in some cases Türck cells, were present in 14 cases (10·3 per cent). This was thought to be due to hyper-stimulation of the reticulo-endothelial system, especially in the early stages of luminising, and was quite evident in one case. Blood examination on this woman at a pre-employment examination three weeks before she began luminising was normal in all respects but after employment for only five days re-examination showed that her stained film contained several primitive cells of the monocytic type.

No skin lesions definitely attributable to beta radiation were observed, but four girls had red patches on the fingers which, although they may have been domestic in origin, are being kept under observation.

In the luminising rooms of two factories considerable contamination of floors, benches and overalls was found, while the contamination of waste buckets, owing to infrequent emptying and inadequate cleaning, was also noted.

Most firms were careful to see that the luminisers wore the National Physical Laboratory films at least as fully as required by the Regulations. The dosages shown were in most cases well below the level of 0·3R per week but the reports on four factories stated that some of the films were spotted, indicating contamination by radio-active dust.

In three instances the dosages were higher than the tolerance level. In one of these, a dosage of 0·6R gamma and 1·2R beta radiation was due to failure to wear the rubber apron provided, the overalls worn showing contamination even after laundering. In another case, a supervisor with thirty years' experience, a dosage of 0·5R gamma and 1·6R beta radiation was due to her habit of mixing the luminous compound without taking sufficient precautions to avoid contamination. A dosage of 0·1R gamma and 0·8R beta in the third case was thought to be due to the large number of luminised instruments habitually left on the benches.

X-Ray Workers

Eight firms were visited and 63 male and 9 female operatives examined during the year. Six of these firms were engaged in the production and testing of X-ray equipment, while the remaining two firms were using X-rays for testing foods and metals respectively. The number of cases in which slight abnormalities were found was leucocytosis 2, relative lymphocytosis without neutropenia 9, slight anaemia 3, absolute lymphocytosis with neutropenia 1, and slight leucopenia 1.

Radium Workers

Two firms using radium for purposes other than luminising or radiography were visited. In one firm engaged on the manufacture of luminous compound, 8 men and 2 women were examined, none of whom showed any abnormalities of the blood picture. In the other firm, where radium foil was used, 2 men and 2 women were examined, all of whom were in good health, but one woman was slightly anaemic and the other had a slight relative lymphocytosis.

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Radioisotope Workers

Thirty-four male operatives and one female were examined at four firms using various radioisotopes including Cobalt 60, Iridium 192 and Thallium 204. The general health of these operatives was good, the blood picture showing only slight and infrequent abnormalities. The results of film tests in all cases showed a very satisfactory low dosage.

In seven firms employing 72 radiographers or operatives (61 male and 11 female) where both X-rays and radioisotopes were used, all were found to be in good health with no evidence of dermatitis or burns. The highest incidence of abnormality in the blood picture was in radiographers employed " on site " where adequate protection presents difficulty. Two of these workers showed a gradually increasing leucocytosis, in one case accompanied by the presence of many abnormal cells in the stained film which may have indicated a " pre-leukaemic " condition. Both these men were removed from further contact with ionising radiations. Other slight abnormalities found were leucocytosis 5, leucopenia 2, relative lymphocytosis 6, absolute lymphocytosis 3, neutropenia 4, anaemia 1. Most of the workers on site found difficulty in obtaining adequate records of dosage, partly because their work was so irregular.

Lead

Nineteen firms were visited at which blood examinations of 171 male workers employed on processes involving exposure to lead were made. Five of these visits were made because cases of lead poisoning had already been notified by the occupiers, and all other employees of these firms exposed to a lead hazard were then examined. Fourteen men complained of abdominal pain, three of weakness of the hand grip, while one man had severe peripheral neuritis of the hands and feet and two men showed a blue line on their gums.

In 53 cases blood examination showed evidence of lead absorption as judged by anaemia and the punctate basophilia count; in 30 cases the level of punctate basophilia was above 1,000 per million red blood cells without accompanying anaemia; in 19 cases some degree of anaemia only was present, without a level of punctate basophilia above 1,000 per million. Thus 102 of the 171 examined showed a blood picture which could be considered as indicating lead absorption.

Benzene

Clinical and blood examinations were carried out on 27 male and 16 female operatives using benzene in various processes in nine firms. No serious disturbances of health were present, the main complaints being lassitude 7, gastric disturbance 3, vertigo 1 and dyspnoea in one woman suffering, however, from a cardiac disorder. Only three cases of leucopenia, two of them associated with anaemia, were found. These cases occurred in a firm using benzene as a rubber solvent, where five workers out of a further nine examined showed slight deviations from the normal blood picture in the form of neutropenia 2, relative lymphocytosis without neutropenia 2, and leucocytosis 1. Two of the firms visited later substituted toluene for benzene.

DERMATITIS

The steady decline in the number of voluntary notifications of industrial dermatitis during the past few years continued in 1955, the number of cases notified being 2,902, compared with 2,930 in the previous year. The analyses by occupation and by industry of these cases are shown in Tables 31 and 32. Although these voluntary notifications have again been of assistance in indicating processes in which dermatitis has occurred, they cannot be used to

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calculate the incidence of dermatitis in specified occupations or industries. It is of interest, however, that for the last three years the largest number of voluntary notifications received, not necessarily indicating the highest incidence of industrial dermatitis, has been of workers in unskilled occupations and that the next five occupational groups in descending order of the number of voluntary notifications made have remained in the same order over the three-year period. These occupational groups were: workers in metal manufacture, engineering and allied trades; textile workers; coal gas and coke makers, workers in chemical and allied trades; warehousemen, storekeepers, packers, bottlers; makers of foods, drinks and tobacco.

TABLE 31

DERMATITIS CASES VOLUNTARILY NOTIFIED: ANALYSIS BY OCCUPATION

Order (Occupation)	Total		
	1953	1954	1955
I. Fishermen	—	—	—
II. Agricultural, horticultural and forestry occupations	—	—	—
III. Mining and quarrying occupations	—	—	—
IV. Workers in the treatment of non-metalliferous mining products (other than coal)	53	56	62
V. Coal gas and coke makers, workers in chemical and allied trades	181	138	163
VI. Workers in metal manufacture, engineering and allied trades	829	761	801
VII. Textile workers	203	188	193
VIII. Tanners, etc., leather goods makers, fur dressers	60	67	60
IX. Makers of textile goods and articles of dress (not boots and shoes)	39	33	19
X. Makers of foods, drinks and tobacco	88	114	96
XI. Workers in wood, cane and cork	84	57	41
XII. Makers of and workers in paper and paper board, bookbinders and printers	34	48	53
XIII. Makers of products not elsewhere specified	60	72	69
XIV. Workers in building and contracting	70	74	43
XV. Painters and decorators	80	65	76
XVI. Administrators, directors, managers, N.E.S.	4	8	9
XVII. Persons employed in transport and communications	53	50	68
XVIII. Commercial, finance and insurance occupations (excluding clerks)	6	—	8
XIX. Professional and technical occupations (excluding clerks)	26	26	28
XX. Persons employed in defence services	7	3	7
XXI. Persons engaged professionally in entertainments and sport	—	—	—
XXII. Persons engaged in personal service (including institutions, clubs, hotels, etc.)	50	61	65
XXIII. Clerks, typists, etc.	10	8	9
XXIV. Warehousemen, storekeepers, packers, bottlers	112	116	102
XXV. Stationary engine drivers, crane drivers, tractor drivers, etc., stokers, etc.	58	62	55
XXVI. Workers in unskilled occupations (N.E.S.)	990	917	869
XXVII. Other and undefined workers	24	6	6
XXVIII. Not gainfully occupied	—	—	—
TOTALS	3,121	2,930	2,902

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A case which appeared to be due to allergy was that of a man, aged 35, engaged in preparing and mounting crystals of thallium sodium iodide before they were made radioactive. During a period of three months on this work, on three occasions he developed severe burn-like lesions, with some ulceration on his hands and forearms. Two other men employed on the same work had no skin trouble.

TABLE 32

DERMATITIS CASES VOLUNTARILY NOTIFIED: ANALYSIS BY INDUSTRY

Industry	No. of Cases			Industry	No. of Cases		
	1953	1954	1955		1953	1954	1955
Textiles				**Non-textiles (contd.)**			
Cotton	101	112	98	Other furniture making	33	27	20
Wool, worsted and shoddy	34	30	52	Pottery	19	18	22
Flax, hemp and jute	14	17	22	Glass	30	27	38
Silk, rayon, etc.	34	23	20	Artificial manure	—	2	—
Hosiery	1	—	2	Coal tar	16	21	7
Other textiles	21	20	12	Other chemicals	219	200	266
Non-textiles				Paint, colours and varnish	9	11	16
Brick, pipe and tile-making	18	19	18	Tanning, currying leather	50	52	46
Other clay, stone, lime and cement	56	41	38	Textile printing, bleaching and dyeing	75	83	85
Metal extracting and refining	22	19	11	Cloth finishing, raising, lapping, making-up and packing	2	1	2
Metal conversion	48	30	31	Job dyeing, other finishing, cleaning and dyeing	11	4	6
Iron, steel and other metal rolling	55	54	45	Laundries	7	6	7
Metal tube making and wire drawing	22	17	10	Tailoring	20	17	11
Metal founding	92	99	72	Dress, millinery, underclothing and other wearing apparel	13	11	4
Metal galvanising, tinning, plating and enamelling	29	22	20	Boots, shoes, slippers and clogs	24	36	30
Marine engine-building and repairing	13	13	24	Rubber trades	83	90	84
Locomotive-building and repairing	22	20	14	Paper, cardboard and millboard making	36	42	47
Other engine-building, transmission machinery	34	28	27	Letterpress and lithographic printing and book-binding	25	26	20
Boiler making	3	5	2	Cardboard and paper box-making	5	5	7
Constructional engineering	28	26	24	Other printing, photography, etc.	18	9	13
Electrical engineering	180	154	140	Flour and other milling	28	21	18
Hydraulic, ventilating and pneumatic engineering	15	10	19	Bakeries	103	65	65
Machine-tool and other tool-making	29	31	40	Confectionery (sugar), groceries, etc.	62	74	75
Textile machinery and accessories	12	9	20	Other foods	60	82	57
Other miscellaneous machine-making	68	54	54	Alcoholic drink	9	10	10
General and jobbing engineering, making and repairing machinery	128	134	130	Non-alcoholic drink	7	5	1
Railway and tramway plant and vehicles	58	54	44	Tobacco and matches	8	8	12
Motor vehicles (other than steam) motor cycles, cycles, carts and carriages	250	244	275	Oilcake, oil refining and extracting	20	19	26
Ordnance and munitions of war	49	56	45	Soap, starch, candles, etc.	3	1	3
Light metal trades	51	71	66	Fine instruments, jewellery, sports articles, etc.	27	44	24
Industrial appliances (locks, bolts, screws, springs, chains, etc.)	57	63	55	Gas works	64	34	33
Miscellaneous metal trades	38	32	47	Electrical stations (S.103)	26	29	32
Shipbuilding (including S.106)	84	64	67	Other miscellaneous industries	45	42	38
Aircraft	86	80	74	Docks, etc. (S.105)	42	41	40
Sawmills, joinery and general woodworking	54	30	28	Construction: building operations (S.107)	63	49	33
Box and packing case making	4	7	1	Maintenance: building operations (S.107)	10	5	16
Brushes and other special woodware	2	1	3	Demolition: building operations (S.107)	2	—	—
Other builders materials	5	7	8	Works of engineering construction (S.108)	9	3	8
Cabinet and chair making, upholstery	19	10	10	Warehouses (S.105)	2	4	12
				Unclassifiable	—	—	—
				TOTAL	3,121	2,930	2,902

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CHAPTER 17

Appointed Factory Doctors

THE total number of examinations of young persons for employment under the Factories Acts carried out in 1955 was 509,620, an increase of 113 on the total for the previous year. Of this number, 268,207, an increase of 1,398 and 52·6 per cent of the total, were examinations of male young persons, a proportion very similar to that in 1954. The number of examinations of female young persons, however, decreased by 1,285, mainly due to a reduction of 3,862 in first examinations after leaving school, this reduction being offset by an increase of 2,577 shown under subsequent examinations.

The total number of first examinations after leaving school decreased by 3,201, while subsequent examinations increased by 3,095 over the previous year. This trend is thought to be a continuation of that noted in 1954 and to be due in part to the reasons then put forward, namely, that more occupiers are becoming aware of their statutory obligations to inform Appointed Factory Doctors of young persons due for subsequent examinations and also that Appointed Factory Doctors are making a more precise apportionment of the two categories in their records of examinations.

The numbers of Conditional Certificates granted for male and female young persons showed increases of 341 and 703 respectively over the previous year, while the number of Provisional Certificates was reduced by 14 and 88 respectively.

The number of rejections due to all causes was 1,676, being 321 fewer than in the previous year, the reductions for male and female young persons being 134 and 187. Table 34 shows that pediculosis capitis among females was the cause of the greatest number of rejections (501), but this was a considerable reduction on the 672 rejections for this condition in the previous year. Refractive errors caused the rejection of 183 male and 185 female young persons, while, in each sex, skin affections accounted for the next highest number of rejections, 42 and 86 respectively.

An Appointed Factory Doctor in a letter accompanying his first annual report referred to the excellent physique of most juveniles. He had found it difficult to persuade girls to wear glasses when necessary, as they consider their cosmetic effect to be undesirable, while a few of the boys were afraid of being " ragged " by their friends if they should appear in glasses. He was sorry to note that on the whole juveniles, after leaving school, where they were under the care of the school dental service, were loath to obtain dental treatment until they were in pain, although girls seemed to pay more attention to their teeth and some of them made regular visits to a dental surgeon.

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TABLE 33

EXAMINATIONS FOR CERTIFICATES OF FITNESS FOR EMPLOYMENT UNDER THE FACTORIES ACTS

(Sections 81, 99 and 100 of Factories Act, 1937, as amended by the Factories Act, 1948)

Young Persons presented as being between 15 and 18 years of age (each examination of each young person being counted)	Number of Examinations			Number of Certificates						Number of Rejections	
				Without Conditions		Conditional		Provisional			
	Male	Female	Total	Male	Female	Male	Female	Male	Female	Male	Female
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. First examination after leaving school for employment under the Factories Acts... ...	142,721	123,600	266,321	135,102	115,200	5,987	6,281	1,194	1,398	445	714
B. Subsequent examinations including annual and those due to change of employment and those following conditional or provisional certificates	118,072	117,813	235,885	112,784	110,732	4,499	5,592	672	1,110	122	374
C. Boys over 16 years of age for employment at night	7,414	—	7,414	7,393	—	—	—	—	—	21	—
TOTAL	268,207	241,413	509,620	255,279	225,932	10,486	11,873	1,866	2,508	588	1,088

TABLE 34

EXAMINATIONS FOR CERTIFICATES OF FITNESS: CAUSES OF REJECTION

Defect or Disease	Number		Defect or Disease	Number	
	Male	Female		Male	Female
Malnutrition	5	5	(Brought forward)	403	898
Undersize	27	7	Circulatory System: Heart	39	32
Deformity	14	7	" " Anaemia ...	1	26
Skin	42	86	Nervous system: Chorea	—	4
Pediculosis	16	501	" " Epilepsy	39	44
Eyes: Refractive errors	183	185	" " Mental defect ...	14	10
" or eyelids: Other	13	6	" " Other	7	5
Mouth and teeth	21	26	Bones and joints	9	5
Nose	2	—	Specific fevers	1	2
Throat	2	3	Rheumatism	4	5
Ears: Defective hearing	16	10	Hernia...	33	—
" Other	12	19	Other causes	33	57
Glands	3	1			
Respiratory System: Tuberculosis ...	15	10			
" " Other	37	32			
			TOTALS ...	588	1,088
(Carried forward)	408	898	TOTAL	1,676	

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TABLE 35
DANGEROUS TRADES: PARTICULARS OF DUTIES PERFORMED BY APPOINTED FACTORY DOCTORS

Industry (1)	Examinations Each examination of each Worker is counted: Males (2)	Females (3)	Total (4)	Suspensions*: Males (5)	Females (6)	Total (7)	Rejections on first Examination as unfit (8)	Certificates permitting return to work after Suspension (9)
A.								
Works in which periodical medical examination is required under special regulations:—								
CHEMICALS: Total	63,742	11,888	75,630	111	13	124	286	56
(a) Nitro and Amido processes	50,540	10,219	60,759	52	12	64	284	34
(b) Chrome processes ...	13,202	1,669	14,871	59	1	60	2	22
CHROMIUM PLATING	84,400	26,516	110,916	222	62	284	†	186
ELECTRIC ACCUMULATORS ...	40,651	5,196	46,847	16	1	17	45	3
HEADING OF YARN	68	7	75	—	—	—	†	—
INDIA-RUBBER: Total ...	8,398	3,089	11,487	17	4	21	†	13
(a) Lead processes	4,460	755	5,215	10	3	13	†	13
(b) Fume processes	3,938	2,334	6,272	7	1	8	†	—
LEAD COMPOUNDS (Carbonate, etc.)	18,664	—	18,664	9	—	9	†	1
LEAD SMELTING, ETC. Total...	29,469	—	29,469	32	—	32	†	10
(a) Smelting of lead, and making of flaked litharge ...	27,830	—	27 830	31	—	31	†	10
(b) Making of spelter ...	89	—	89	1	—	1	†	—
(c) Making of red and orange lead	1,550	—	1,550	—	—	—	†	—
LUMINISING	209	746	955	2	—	2	3	—
MULE SPINNING (HEALTH) 1953	14,893	2,787	17,680	†	†	†	†	†
PAINT AND COLOUR WORKS ...	22,156	2,136	24,292	6	—	6	†	1
PATENT FUEL	1,841	—	1,841	†	†	†	†	†
POTTERY (HEALTH & WELFARE) 1950: Total	8,344	6,092	14,436	7	5	12	—	2
(a) Lead Processes (see Part I of the First Schedule to Regulations):								
(i) Frit, glaze and colour mixing, etc.	5,605	21	5,626	2	—	2	—	1
(ii) Flow material preparation, etc.	—	—	—	—	—	—	—	—
(iii) Colour blowing, etc. ...	114	2,394	2,508	—	4	4	—	—
(iv) Ground laying, colour dusting	367	1,036	1,403	—	1	1	—	—
(v) Colour grinding ...	846	40	886	1	—	1	—	—
(vi) Litho-transfer making...	400	2,030	2,430	—	—	—	—	—
(vii) Other lead processes ...	694	136	830	3	—	3	—	—
(b) Regulation 6(7): Lifting or carrying by young persons	285	421	706	1	—	1	—	1
(c) Regulation 25(2): Colour Blowing (Eyesight) ...	33	14	47	—	—	—	—	—
TINNING OF HOLLOW-WARE, ETC.	1,779	272	2,051	—	—	—	†	—
VITREOUS ENAMELLING OF METAL OR GLASS	2,962	22,05	5,167	3	1	4	†	1
B.								
Processes Involving use of Lead Compounds: ...	3,707	3,938	7,645	2	47	49	†	—
Periodical medical examination of women and young persons required under s. 59 or s. 109 of the Factories Act, 1937 and not under Group A above.								
Total of A and B	301,283	65,872	367,155	427	133	560	334	273
C.								
Works in which a Voluntary Periodic Medical Examination is made: Total ...	44,839	12,222	57,061	196	145	341	†	98
CHEMICALS (other than in A) ...	4,170	2,436	6,606	30	49	79	†	18
CHROME PROCESSES (other than those in A)	2,014	767	2,781	2	2	4	†	4
COTTON MULE SPINNING ...	275	14	289	1	—	1	†	—
LEAD ROLLING	833	—	833	—	—	—	†	—
LEAD PROCESSES (other than those in A)	11,064	2,112	13,176	32	5	37	†	22
MERCURY OR ITS COMPOUNDS OR THEIR USE	289	39	328	1	—	1	†	—
PARAFFIN SHED WORKERS ...	123	—	123	—	—	—	†	—
PITCH AND TAR WORKERS (other than in A)	3,363	60	3,423	4	—	4	†	2
RADIATION HAZARDS (other than in A)	2,017	1,141	3,158	2	1	3	†	1
SHIPBREAKING	728	—	728	1	—	1	†	1
TRINITROTOLUENE AND OTHER EXPLOSIVES	11,453	1,975	13,428	114	30	144	†	50
MISCELLANEOUS	8,510	3,678	12,188	9	58	67	†	—

* Suspensions of all descriptions (excluding initial rejections — see col. 8) under Regulations, made at the periodical examination or otherwise; including therefore those occasioned by notice of poisoning received by the Appointed Factory Doctor.

† Not applicable.

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PART III. SPECIAL REGULATIONS

CHAPTER 18

The Chemical Works Regulations, 1922

IN RECENT years there has been a profound change in the chemical industry in this country. The manufacture of heavy chemicals has increased considerably and there has been a tendency for this work to be concentrated in a comparatively small number of large factories controlled by large organizations. For example, very few gasworks now distil tar or treat their ammoniacal liquor, these materials being transferred in tank wagons to central tar distilleries or chemical works. The manufacture of acids and alkalis is normally carried on at large works.

Since the war, oil-refining in this country has increased enormously. The industry is still expanding and in connection with it a large chemical industry is growing up. By the use of modern processes a whole series of organic chemicals is being made available for use in the plastics and other industries Several oil refineries are now putting in sulphur-recovery plants because of the shortage of sulphur and the need for dealing with effluent sulphuretted hydrogen arising from certain crude oils. The sulphuretted hydrogen, which originally was burned to waste, is now processed to produce sulphur and in some cases may eventually be converted to sulphuric acid which can be used in the oil-refining processes. In time, the petroleum industry may become self-supporting as regards sulphuric acid and may even be able to sell a surplus. The oil refineries and associated plant, although seldom subject to the Chemical Works Regulations, are modern, most processes being carried out in closed circuits.

There has also been a considerable increase in the manufacture of fine chemicals, many of which are extremely complex and require numerous stages in their preparation. The fine chemical industry has grown owing to the rapid increase in the use of synthetic drugs, antibiotics and insecticides, and to the fact that industry generally is now using many more chemicals to assist production and to improve products. Many fine chemicals were originally manufactured in small plant in small factories, but, here again, the work now tends to be concentrated in larger units.

With the extended use of chemicals in all branches of industry, the hazards once associated with the chemical industry alone can now be found almost anywhere. The managements of non-chemical works are not always fully aware of the dangers associated with the materials which they handle and Inspectors have to exercise constant vigilance in watching for these hazards.

Chlorine gas is readily available and for some years it has been extensively used in the treatment of flour and of paper pulp, but safe methods of handling and use have been devised and little trouble arises. In some food factories, the disinfestation of dried fruits was carried out by means of methyl bromide, a very toxic substance. In almost all places, this has now been replaced by ethylene oxide which, although very inflammable, is far less toxic. By using solid carbon dioxide together with ethylene oxide the risk from fire and explosion can be eliminated. In the engineering industry, acids, alkalis, chromates and cyanides are used regularly. Both employers and operatives, who have little or no knowledge of chemical hazards, have to be trained in the precautions to be taken with these substances.

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These changes in the use of chemicals in industry were reflected to some extent in the Factories Act, 1937, which applied to all factories some provisions which had hitherto related only to works subject to the Chemical Works Regulations. For example, Section 18 of the Act deals with vessels containing scalding or corrosive liquids into which a person might fall, while Section 47 covers the risks from poisoning arising from toxic gases or dusts. The changes made by that Act had become necessary because chemical hazards were arising in all types of industry and because the Schedule to the Chemical Works Regulations did not include many processes carried out in chemical works.

The development of modern chemical processes and plant has in many cases substantially reduced the danger to persons employed. As in all industries, there has been considerable development in the mechanical handling of materials and this has lessened the personal contact with corrosive and inflammable substances. Also, a newly-developed process often makes it possible to cut out certain reactions which necessitated the handling of intermediate products. Inspectors report a number of cases in which the whole of a chemical manufacture can be carried out in a closed system, usually under negative pressure. Examples are quoted of works using such plant for the handling of phosgene, phosphorus compounds, manganese compounds and for the extraction of fats from bones and other animal waste products.

The introduction of the modern continuous pipe still has removed many hazards associated with the pot-type tar still. The whole plant is much cleaner and there is no risk associated with entry into stills. In addition, the process is controlled by instruments and sight-glasses, thus avoiding the need for the handling of samples. Other examples are found in processes for the synthesis of complex organic compounds and their subsequent extraction and purification by distillation. Cases are quoted of complete plants being constructed in glass and fitted with electronic aids for control and for shutting down the plant in case of failure. In fact, it is true to say that automation is highly developed in the modern chemical plant.

The old batch process for the manufacture of hydrochloric acid, to which Regulation 2(a) of the Chemical Works Regulations was directed, is fast being replaced by a continuous process, in which there is no raking of the partly converted salt cake and the plant is maintained continuously under negative pressure. Common salt and sulphuric acid are mixed continuously in a series of vessels which are enclosed and kept under slight vacuum. Here, the first stage of the reaction takes place, with the evolution of hydrochloric acid. The hydrochloric acid is exhausted to towers where it is absorbed in water. The remaining mass is run off into a series of continuous rotary roasting furnaces, also under vacuum, where the second part of the reaction proceeds and further hydrochloric acid is produced. The salt cake produced at the end of the process is a fine white powder ready for packaging.

Because of the demand for phosphorus compounds of very high purity, most of these are now manufactured from elementary phosphorus and the manufacture of this element in large quantities has become necessary. Elementary phosphorus is produced by treating phosphate rock with coke in continuous electric furnaces, when the element distils off, with the evolution of carbon monoxide. The phosphorus is condensed and stored under water, the carbon monoxide being burned in waste heat boilers. Although the plants are modern, there have been a few cases of phosphorus poisoning and some instances of gassing due to carbon monoxide. Steps have now been taken to deal with both these hazards and it is hoped that further cases will be prevented. In the meantime, all operatives are being medically examined at

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regular intervals to ensure early diagnosis of the absorption of phosphorus. In order that escapes of gas during repairs can be dealt with, breathing apparatus to which fresh air is supplied has been universally adopted. A ring main, containing fresh air under pressure and having a number of points at which breathing apparatus can be connected, has been fitted round the works.

Many phosphorus compounds are both inflammable and toxic, not the least hazardous of these being the metallic phosphides. The kind of precautions which have to be taken is indicated by those necessary in the packing of sodium phosphide. The material, after manufacture, is dried in a gas-fired oven fitted with exhaust ventilation. Because sodium phosphide ignites spontaneously when in contact with water, filling of containers cannot be carried out when the wet-bulb thermometer is within 3°F. of the dry-bulb thermometer and the material has then to be damped with a light-fraction mineral oil. Fire-fighting precautions in the department have to be of the highest standard.

Many processes in the fine chemical industry are not subject to the Chemical Works Regulations, although these Regulations may be applicable to a small part of the process such as the use of chlorine.

Quite apart from the chemical risks associated with manufacture, it is often necessary to protect persons against the finished product, as in the case of drugs which, in the concentrated form, are toxic. For example, a possible health hazard was discovered when a man was found grinding a drug, using a respirator to prevent the inhalation of the dust. This was not proving effective and the occupier was supplying another drug to counteract the one being packed. Good exhaust ventilation was the correct answer to the problem and this was subsequently provided. In the handling of benzidine, special precautions have to be taken. One factory adopts the following procedure: the material is packed in special drums, which are enamelled on the inside to facilitate washing out, and these are emptied into a booth having a combination of exhaust-draught and water-spray. The drum receives a thorough washing by means of the spray and the operator is fully protected by special clothing and a respirator. From this point onwards, the benzidine is in the form of a slurry and does not enter the air of the workroom. It is now intended to mechanize the plant to a greater extent so that the number of persons engaged in the work is reduced. All persons concerned will undergo periodic medical examination.

Many insecticides, such as the organic phosphorus and organic mercury compounds, are very toxic to human beings and great care has to be exercised when handling them. A very high standard of protective clothing is necessary, together with washing accommodation, often including baths. At all works handling these materials, workers are medically examined at regular intervals, clinical examination often being supplemented by blood tests. A rather similar problem arises with the manufacture or extraction of some hormones and the precautions taken follow the same lines.

Although, as indicated above, the Chemical Works Regulations do not apply to certain chemical works and other factories with chemical hazards, Inspectors find generally that occupiers adopt precautions which are in line with the Regulations. Occupiers also follow the codes of practice and advisory leaflets issued by the manufacturers' associations both in this country and abroad, and they often consult this Department when new processes are to be commenced.

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The relevant sections of the Factories Act, 1937, have proved adequate to deal with the basic chemical hazards in factories. It would be almost impossible to include in a schedule all chemical processes now carried on and, as has been indicated, chemical hazards are not now limited to chemical works.

Inspectors report that in the larger works the standard of compliance with the Chemical Works Regulations is extremely high. In some smaller works the standard is lower, although very few really bad cases have been noted. The following notes describing compliance with some of the Regulations will be of interest.

In the past, objections to the fencing of vessels as required by Regulation 1 were usually based on the fact that fencing to a height of 3 ft. made work at the vessel unduly difficult. For example, raking or mixing could not easily be done over so high a fence and a lower one was urged. Many buildings were too low for overhead cranes to be used and in these cases there was something in the plea. In modern works where most handling is done mechanically, these objections do not arise and Inspectors report that in very few cases is the protection below standard. Cases are, however, sometimes reported in which new vats are installed with too low fencing because it is often expensive to achieve the statutory standard. Inspectors find that boxes or other articles on which a person can stand are occasionally placed alongside the fencing, thus reducing its effectiveness. This bad practice has to be carefully guarded against.

Section 47 of the Factories Act, 1937, contains provision for exhaust-draught similar to that required by Regulation 2 of the Chemical Works Regulations, but Section 47 is much wider in its application. There is, in general, a good standard of compliance with Regulation 2. In fact, as has been mentioned above, many reactions are now carried out in closed plant.

Inspectors report a high standard of lighting in the modern chemical works, a distinct improvement on the conditions of thirty years ago. Even where inflammable or explosive conditions exist, safe forms of lighting are used which achieve a standard of illumination in excess of that required by Regulation 4(a). Electrical instruments and other apparatus in use in such areas are usually of certified flameproof type, unless they are certified as being intrinsically safe.

The fitting of safety valves, as required by Regulation 5, to chemical plant which operates under pressure, has always presented certain problems. Valves are likely to become unreliable as the result of corrosion, and where a vessel is also required to work at certain times at a negative pressure it is not always easy to find a satisfactory valve. Where the gas to be released is toxic or inflammable, a pipe should be fitted to the valve to conduct the escaping gas to a safe place outside the workroom. At one factory where hydrogen is evolved in a reaction, a special type of valve has been fitted, the gas being discharged to the open air, well above the roof of the building. In another case, where chlorine is handled, attempts are being made to devise a scheme by which it is discharged into empty chlorine-storage tanks. The regular maintenance of all safety valves is extremely important, a fact which appears to be realized by most occupiers.

At many chemical works, the breathing and resuscitation apparatus and the life-belts are, fortunately, very seldom used. In consequence, Inspectors often find that the statutory monthly examination of this equipment is allowed to lapse or that a record of examination is not kept. It is extremely important that this apparatus should always be fit for immediate use and this can be

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ensured only if there is regular examination and maintenance. A further important matter is the training of a sufficient number of persons in the use of this apparatus. During the war, everyone learned how to adjust his respirator quickly, but it is amazing in how many works only a few persons know where the breathing apparatus is kept or how to use it. The scheme adopted at one explosives factory could well be adopted by many other chemical users. Here, the training is in the hands of the full-time medical officer. All firemen, in addition to having first aid knowledge, are fully trained in the use of the breathing and resuscitation apparatus and in giving artificial respiration. All workers in departments in which fumes are liable to be evolved must become proficient in the use of breathing apparatus.

Regulation 7 requires that any vessel which has contained a dangerous fume must be isolated and certified free from such fume before a person enters it without wearing breathing apparatus. Inspectors find that this requirement is usually well carried out; in fact, some factories issue a "permit-to-work" before any work in such a vessel is started. Normally, the "permit-to-work" has to be signed by the works chemist or works engineer after satisfactory tests on the vessel have been made, and the plant cannot be recomissioned until the permit has been returned, indicating that the work has been completed. At one works where various very poisonous materials are used, a more elaborate scheme is in force. No person may enter any enclosed space unless he has obtained a certificate signed by a chemist and an engineer nominated for the purpose. When there are unusual circumstances involving, for example, carbon disulphide, a second certificate must be obtained signed by three persons, namely the technical manager, the resident engineer and the safety officer. Incidentally, this permit scheme is also used in the prevention of fire and explosion, as the following example shows. An alteration in a room in which carbon disulphide was used necessitated a portion being cut from a steel joist. The special certificate laid down that all carbon disulphide should be drained from the plant, that the ventilation should be kept in full operation and that the cutting should be done with a hack-saw constantly flooded with water. In addition, a fireman stood by with equipment during the whole operation.

The method of providing a supply of drenching water as required by Regulation 10 varies greatly in different works. In some, slipper baths kept full of water are placed in suitable situations in the works, while in others, reliance is placed on hoses connected to a large-bore water main. Perhaps the best arrangement which was seen was an overhead shower which could be operated either by pulling a handle connected to a valve or by simply standing on a platform, the depression of which operates the valve. In the best devices of this type, the water is delivered warm from a tank, the water being kept warm at all times by an immersion-heater. This use of warm water reduces the shock which is inevitable when a man is suddenly drenched with a large quantity of cold water.

Eye-wash bottles, required by Regulation 10, are most important where any corrosive material is handled. Generally the bottles are well maintained and the occupiers have taken steps to provide bottles which can conveniently be used by a person whose eyes may be affected. These bottles are usually kept in special cupboards placed where they can be readily used. At one works, the cupboard doors are hinged at the top and do not extend to the bottom of the cupboard. A hand can be slipped under the door, the door pulled open and the bottle gripped immediately. The type of bottle used is such that as soon as it is tipped a stream of distilled water flows out.

The standard of first aid in most large chemical works is high. It is quite usual for trained nurses to be available at all times in well-equipped first aid

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rooms; a few works have full-time works medical officers. It is also usual to train staff in first aid as well as in the use of breathing and resuscitation apparatus. In the smaller works, the arrangements are not so elaborate, although, in general, conditions appear to be satisfactory. There is a tendency in all chemical works to train operatives both in the work and as to the hazards to be expected. This has had the beneficial result that even the most junior worker has a fuller appreciation of the work he is doing. Incidentally, tidier, cleaner and therefore safer, chemical works have resulted.

Part II of the Regulations calls for little comment except that the provisions contained in it are applied voluntarily to many processes not subject to the Regulations. For example, bath accommodation and protective clothing is provided in many works where harmful chemicals are handled. Most important is the fact that industry has been prepared to institute voluntary periodical medical examination in many cases where the processes are such that the health of the workers may be affected. These medical examinations often include blood tests, urine examination and X-ray examinations.

CHAPTER 19

The Indiarubber Regulations, 1922 and 1955

SINCE the Indiarubber Regulations were made in 1922, there has been a profound change in the rubber industry. New raw materials have been brought into use and methods of manufacture have been modified.

Lead compounds, both as accelerators and as filling materials, have been replaced in rubber mixes by other materials, the use of which does not involve any special health hazard. Whereas, in 1922, lead compounds were used at a large percentage of horizontal mixing rolls, it is now common practice to add the lead either already incorporated with rubber, or as an oily suspension which renders it less dusty. The hazard of lead dust is thus limited to a few factories and in these to a few machines only. This preliminary mixing is now often done in enclosed, mechanically exhausted, machines. Satisfactory methods of applying exhaust to horizontal mixing rolls have been developed and, in general, it can be said that there is today no serious lead dust problem in the indiarubber industry. Very recently, some branches of the industry began adding finely divided lead metal to rubber mixes, but the process is so conducted and arranged that no hazard arises.

The solvents used in the rubber trade are in the main the same as those used when the Regulations were made, although there has been a marked decrease in the use of carbon disulphide. By the time the Regulations of 1955 came into force prohibiting the use of carbon disulphide in cloth proofing its use in that process had already ceased and Inspectors report that in certain other branches of the industry it is unusual to find carbon disulphide in use. It is still used, however, in the manufacture of some types of surgical rubber goods, including gloves and tubing, but these articles are quite extensively made without the use of carbon disulphide, and to quote one Inspector, "There is probably no justification in the rubber industry for the use of carbon disulphide, which should be relegated to the analytical or research laboratory".

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In general, Inspectors report that, where carbon disulphide is used, a high standard of exhaust ventilation is provided, but that there were cases of its use, for affixing soles, in small boot-repairing premises where the conditions as to ventilation were somewhat unsatisfactory. Since the Regulations do not apply to repair work, Inspectors have dealt with these cases under Sections 4 and 47 of the Factories Act, 1937.

Another solvent, the use of which has considerably decreased, is benzene. For many years, Inspectors have been advocating its replacement by a less toxic solvent, and their efforts have borne fruit. The usual substances used in place of benzene are toluene, xylene or solvent naphtha. Occupiers are sometimes slow to experiment with alternatives to benzene, and, as the provisos to Regulations 2 and 5 give tacit approval to its use, considerable pressure by Inspectors is often necessary before agreement is reached on substitution. At one factory, until quite recently, benzene was in constant use. Representations were made to the occupiers to use a less harmful substance and visits were paid by the District Inspector and a Medical Inspector, who took blood samples. These showed evidence of benzene absorption in some of the workers examined. Ultimately the firm agreed to replace benzene by other substances except in one process, and experiments are proceeding in the search for a suitable alternative for use in this rather special case.

There are, of course, other instances in which it has not been found possible to find an alternative for benzene, but in these, as a rule, good exhaust ventilation is provided and the proviso to Regulations 2 and 5 is not invoked.

With the introduction of synthetic rubbers there has been some extension of the use of benzene and, here too, a suitable alternative has not yet been found in all cases. Although the Regulations do not apply to the manufacture of goods from synthetic rubbers, Inspectors encourage occupiers to act as if they did. For example, at a rubber factory, a solution of neoprene in benzene and other solvents is manufactured, and applied to metal articles as a preservative. As this work is not a "fume process", as defined in the Regulations, the firm were urged to comply with Section 47 of the Factories Act, 1937, and during 1954 they installed a very powerful exhaust ventilation plant, the inlets to the system being situated along the backs of two workbenches; there were also some lengths of flexible ducting to enable suction points to be taken to work which could not be placed on the workbenches. At one or two visits, Inspectors saw comparatively small articles being painted with the solution and it was evident that the exhaust draught could be more efficiently applied if the job were carried out in an exhausted cabinet upon the bench. The firm's engineer agreed to provide a portable cabinet for this purpose, with flexible ducting connecting it to the main exhaust system. The workers in the solution shop are periodically examined by the Appointed Factory Doctor, although such examination is not, of course, required by the Indiarubber Regulations.

Sulphur chloride and chlorinated hydrocarbons are still in general use in fume processes. The work is almost always done in a satisfactory fume cupboard. The following modification of the fume-cupboard principle to meet particular circumstances is of interest. At a factory where extruded rubber is cold-cured by dipping in sulphur monochloride, the exhaust ventilation arrangements for the cold-cure process were formerly very unsatisfactory, but, in 1952, the firm constructed a fume cupboard 7 ft. 6 in. wide, 9 ft. from front to back and 7 ft. high, with a powerful extraction fan drawing the fumes upwards and delivering them to the open air through an absorbing tower. The width of the cupboard is sufficient to accommodate two dipping

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tanks, end to end, each with its own access door, and, behind each tank, a pair of wooden rails of a width to carry the trays of work. After dipping a tray of work in the tank, the operator places the tray on the rails just behind the tank, and this tray pushes the previous tray back a tray's width and thus the trays gradually travel from front to back of the cupboard and the work on each tray is dry by the time it reaches the back of the cupboard, where the trays are taken off through one or other of two sliding doors.

In the same factory, rubber balls and beach rings are painted with a paint consisting of neoprene solution in trichlorethylene, a process which, although not within the scope of the Regulations, is conducted under exhaust draught, as is also the making of the paint.

Another example is also worth quoting. A firm employs 30 women on a fume process which is carried out at two large tables, each provided with exhaust ventilation. Solutioning is done under a glass frame which forms a continuous "fume cupboard" round the table and the exhaust openings are placed in front of each working position. The air movement obtained is very effective in removing the fume.

Many Inspectors report that conditions in repair factories are often much worse than in those in which articles are manufactured. Although the solvents involved are small in quantity, they are often toxic and are applied by hand near the breathing level. Moreover, exhaust ventilation is often quite difficult to apply.

Solvents are sometimes used to clean parts before repair, for example, as at a large central workshop belonging to a group of collieries, where the repair of conveyor belting is carried on. Some of these belts are made partly of natural indiarubber, but the tendency now is to use other materials, such as polyvinyl chloride, which is not inflammable. Repair is effected by scraping away the damaged surface, cleaning it with carbon tetrachloride and applying a patch with adhesive cement. If this were a process of manufacture it would be a "fume process". The total quantity of carbon tetrachloride used is small; it is kept in containers designed to minimize evaporation and there is good natural ventilation in the workshop. All the persons employed, several of whom are disabled coal miners, undergo monthly medical examination by the Works and Colliery Area Medical Officer.

Large quantities of rubber and rubber solution are now being used in the boot and shoe trade. From the hazard point of view, the work is in many respects similar to repair work. The difficulties often include those associated with the manufacture of rubber solutions.

The introduction of stabilized latex has reduced the number of factories using the cold-cure process. Processes involving the use of latex are normally almost free from health risk, although from time to time some discomfort may arise. Of the foamed rubber industry one Inspector writes: "This industry appears to have few direct risks to health, although there has been some incidence of dermatitis caused by the use of sodium silico-fluoride. Steam, high temperatures and the strong smell of ammonia are, however, problems in this industry and where nothing is done to combat them, conditions may become very bad indeed. We have already dealt with one such firm, while another, on its own initiative, has installed a most elaborate ventilating plant. Developments are taking place in this industry and the tempo will increase. Foamed rubber is being used as a backing for carpets and one company is curing and then granulating the waste products and affixing the substance to a hessian backing to form underfelt. Health risks in this branch of the industry may well increase".

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Latex has also replaced the cold-cure process in a number of factories for the manufacture of gloves, surgical goods, etc., and its use appears to be extending.

Perhaps the most important health hazards associated with the modern rubber trade are those connected with organic accelerators and with filling materials such as asbestos and silica. These hazards are not covered by the existing Regulations but it is possible to deal with them under the main Act.

Many organic accelerators are toxic and almost all are liable to cause dermatitis. They are, of course, used in small quantities, but a limited number of workers may be exposed to high concentrations, and the Department is watching this matter carefully.

For many years, rubber factories have been very dusty due to the extensive use of talc, but only recently has it been realized that this material when inhaled presents a health hazard. The powder was applied to unvulcanized rubber in such a way that in many factories all parts of the workroom became covered with dust and workers themselves were often white from head to foot. The trade is now making a real effort to remove this hazard. In some cases the talc is being applied in a wet or greasy form, and in other cases alternative materials, such as certain silicones which can be applied in a non-dusty form, are being used. Exhaust ventilation was not a satisfactory solution to this dust problem and one must look to widespread substitution of alternative materials if it is to be solved.

There is little doubt that the Indiarubber Regulations of 1922 do not cover all hazards associated with the modern rubber and plastic trades. Factories using synthetic rubbers such as neoprene and butyl rubber are not subject to the Regulations at all. The many synthetic plastics such as polyvinyl chloride and polythene, which for some purposes have replaced rubber, are also outside the scope of the Regulations, although many of the manufacturing processes are similar to those used for rubber. These changes in the industry do not, however, mean that adequate precautions cannot be required, because the 1937 Act embraces, in a general manner, many of the subjects covered by the Regulations.

Revision and extension of the Indiarubber Regulations is under active consideration, but it should be made clear that occupiers, in consultation with Inspectors, have in general complied with the Regulations and other legislation in a common-sense manner and as a result have removed most of the health hazards from the industry. Almost more important are the facts that the industry is continually carrying on research to discover less toxic materials for use in the various processes and that managements are showing an earnest desire to substitute these in all cases where such substitution is proved practicable.

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CHAPTER 20

The Iron and Steel Foundries Regulations, 1953

THESE Regulations came into operation on January 1st, 1954, with the exception of Regulations 7 and 9, which did not come into force until January 1st, 1956. The following survey covers the whole of the initial period of the operation of the Regulations and is a record of great improvement in the conditions obtaining in iron and steel foundries.

In foundries which form part of an organization making specialized products, the standards are, broadly speaking, reasonably high. This is partly due to the fact that the firms have tried to apply to the foundries the standards they had already achieved in the rest of the works. In larger foundries in general, Inspectors' reports indicate that the interest of both Employers' Organizations and Trade Unions has contributed to progress. While the progress made in the smaller foundries, particularly in the jobbing foundries, may not be so marked (due more to shortage of capital than to lack of good intention) there is, nevertheless, steady improvement. It should be borne in mind that improvements in quite small items may prove costly, not only in money and time spent on equipment and its installation, but in the interruption of production and consequent loss of output. Notwithstanding the considerable cost involved, some firms have completely rearranged their working methods in a genuine effort to comply with the spirit as well as with the letter of the Regulations. Such rearrangement is particularly evident in non-mechanized foundries.

Before the Regulations were made, there were foundries in which the standards achieved were not far short of those now legally required. The conditions in such well-run concerns have been, and still are, the yardstick by which less well-managed concerns must be measured, for it is in the day-to-day implementation of the Regulations that the efforts made to ensure compliance are most readily noticeable.

Arrangement and Storage

Efforts towards compliance are particularly noticeable in the matter of general tidiness. Regulation 4, in the words "for the purposes of promoting safety and cleanliness", sets out its intention clearly and in so doing calls upon both employers and workers for co-operation. The following extracts from Inspectors' reports are typical and illustrate both difficulties and accomplishments.

"Bins and bunkers for the bulk storage of sand, fuels and materials are becoming much more common and there is a general movement towards improved tidiness in the storage of moulding boxes, pattern plates, etc. On the other hand, there has not been much development in the provision and use of racks or other receptacles for tools, such as rammers and shovels, which the men like to have close at hand. The usual under-bench drawer provides storage for the smaller items."

"In most cases, satisfactory provision has not been made for tools, although this only involves installing shelves or racks for tool boxes and standing trays for rammers and shovels. Bins have been provided for small articles such as reinforcing wires and other metal articles used in the support of cores in moulds."

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"There has been little difficulty with this Regulation and many foundries are now much tidier places, although some men do not always use the accommodation provided for their gear and tools."

It is probably appreciated that orderliness in a foundry not only leads to greater safety but also to increased production. A foundry whose floor space is untidy is a foundry which is wasting part of its productive capacity. Clear floor space is production space.

Work near Cupolas and Furnaces

This has been well controlled and there seems to be little difficulty in complying with Regulation 5. In a very few cases, practical difficulties associated with plant lay-out, notably in mechanized foundries, have led to my granting, under Regulation 10, a certificate of exemption from strict adherence to the distances prescribed by Regulation 5, and I am satisfied that, by the use of alternative safeguards, the intention of the Regulation is substantially fulfilled.

In some cases, moulding is done within the danger area but no work is carried on by moulders when metal is being obtained from the cupola spout. In others, all moulding in the danger area has been voluntarily discontinued and in one case a low brick wall has been built to stop the moulders working too close to the danger line. Some Inspectors consider that space lost by prohibiting all moulding inside the danger area would be of negligible importance.

Gangways and Pouring Aisles

It is, however, in the provision and maintenance of gangways to the standards laid down that the greatest improvement is attainable. The idea that in a foundry everything on the floor should be without design or order has been proved quite wrong and both in the old and in the new foundries the provision of good main gangways has caused little difficulty. Some rearrangement has been required in some cases and the more orderly stacking of boxes, etc., has often made the provision of a gangway or gangways practicable. A good many of the foundries have used concrete for the gangways, including in one case the addition of "honeycombed" metal squares inserted into the concrete while it is being laid. One firm proposes to use pre-cast concrete paving slabs and has been asked to bevel the edges level with the sand in order to prevent tripping accidents.

The provision of clearly defined pouring aisles is less often seen, particularly where floor moulding is carried on or where a wide variety of articles of different shapes and sizes is cast. Inspectors say, however, that well trodden-down, if devious, paths are usually found. Where metal is carried otherwise than by man-handling, the pouring aisle is necessarily more defined. In some cases, boxes are brought to a central pouring point.

Personal Protective Equipment

Regulation 8 is definite, not only in requiring the provision of protective equipment, including gloves, respirators and goggles or other eye protection but also in requiring the proper use of the equipment by the worker. Inspectors' reports indicate that substantial progress has been made; I am including in this Report a reference to the difficulties and failures because I wish to inculcate in everyone connected with the industry (and I would here emphasize particularly the contribution to be made by the worker) an awareness that, although protective equipment may not be wholly satisfactory, the results of using such as is available fully justify its provision.

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Admittedly, a great deal of criticism can be levelled at the protective equipment provided. Many of the leather and asbestos leggings, spats, etc., are too heavy, and cause unnecessary sweat and fatigue. A great deal could be done to provide a lighter type of equipment. Complaints about goggles are often heard: they "draw" the eyes, they heat up, they restrict side vision and, in some cases, they have been alleged to be inflammable.

I have appointed a Committee to advise upon the type and design of goggles most likely to be acceptable to the wearer and, at the same time to provide the highest standard of protection. I hope at an early date to publish the recommendations of this Committee.

The efficiency of respirators is dependent to a large extent upon their cleanliness and the renewal of the filtering medium. I therefore attach great importance to the provision of respirator cleaning facilities. The ideal, of course, is for each worker to have one respirator in use and one "at the wash"; in some foundries this is already the practice. It is essential that such a service be available in every foundry and the following report from one District illustrates the practicability of such a scheme.

"Yet another firm has introduced a respirator cleaning service. Each worker has been issued with two large metal boxes, in one of which he returns the old and dirty respirator and his goggles to the cleansing station at the end of the shift. Before starting work again, he collects the second box containing his clean respirator and goggles. Each worker's respirator, goggles and boxes are marked with his works number. Three women are employed full-time at the cleansing station."

From another part of the country, it is reported that in a foundry where each respirator is cleaned and disinfected daily, so enabling an issue of a clean respirator to each worker every morning, the scheme costs the firm £750 per year.

I believe that, in due course, the idea of personal protection will be better accepted and the foundry worker will regard all his safeguards as being just as much of a necessity as does, for instance, the welder.

Dust and Fumes.

Progress has been made during the years 1954/5 towards full compliance with Regulation 7, although its specific requirements did not come into force until January 1st, 1956. There is a record of great improvement, upon which the industry deserves congratulation; naturally an ideal state of affairs is not attained, but the industry has taken a very serious view of its obligations and has made an appreciable effort to comply with somewhat onerous and costly requirements. Considerable experimental work was required before the application of certain classes of equipment became a practical proposition, and even now a considerable amount of research and development work has yet to be completed.

Foundry Heating.

The time-honoured heating apparatus of the foundry, the open brazier, received a severe blow when it was known that portable open fires would be prohibited by the Regulations. Reports from the Districts are emphatic that there has been a great reduction in the use of open fires, but that they have not yet disappeared from the foundries. Two years is, of course, too short a time for a complete change in tradition.

Some of the improvements made are worth putting on record:

"A new form of oil-fired open heater, fitted with fans for drawing air in and blowing out the heated air, is about to be tried."

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"In one foundry, low-temperature radiant heating panels have been installed and in another foundry, suspended gas-radiators have been ordered."

"The effect of the Regulation is an increase in the use of slow-combustion stoves (with flues) and in the installation of more elaborate heating arrangements, including unit heaters and, in one case, a hot-air plenum system."

Ladle Drying.

Compliance with Regulation 7(2) has been achieved by setting up ladle-drying stations, often apart from the foundry or in a place where little work is carried on. The means of drying vary from the primitive coke stove (outside a workroom) to an oil-burning air-blast drying plant with appropriate means for removal of fume. There is, in general, satisfactory compliance with this Regulation.

Mould Drying.

The use of open fires has not been wholly discontinued and, indeed, the Regulation does not envisage a total prohibition of their use. Specially-constructed mould stoves are, where practicable, increasingly used. It is reported that when a gas-heated dryer was tried as an experiment in one foundry, the workers, having previously been apprehensive about its use and efficiency, then strongly approved of the device because it gave better results than did the original dryer, namely the bucket of coke. The Report* of the Committee which I appointed to advise me on this subject has been published since the end of the year, and should prove a most helpful source of information on the methods which are most suitable and effective.

Mould and Core Stoves.

Even before the Regulations were introduced, mould and core stoves had received the attention of Inspectors. Reports in general show very satisfactory progress towards complete compliance with Regulation 7(4). Moreover, the introduction of new techniques in core-making, e.g., the carbon dioxide process, has resulted in some reduction in the use of these stoves. A number of new core ovens with modern methods of heating have been built; the fires are outside the stoves, and the hot gases are mechanically circulated. In a very large malleable iron foundry, electric annealing ovens are being installed.

Knock-out Operations.

There is no doubt that when the Regulations were made the requirements of Regulation 7(5) were viewed by foundry occupiers with some dismay for, except in modern, fully-mechanized foundries, there seemed to be no techniques which could be applied to the problem of dust removal at the knock-out. Moreover, the effective separation of the process from other foundry processes, as required by Regulation 7(5)(a), presented many difficulties, which have not yet been entirely overcome. However, the progress made in dust removal, though by no means entirely satisfactory, is real; in the case of small and medium-weight castings the problems of dust control have yielded to research and experiment to a most encouraging degree. It is worth while giving some extracts from District reports in order to show that a real effort is being made.

"Most mechanized foundries have exhaust draught at the knock-out points; although this is probably not as effective as it might be in every case, we now have some idea of how to effect improvement. The real problem

* The Drying of Moulds by Portable Dryers, published by H.M. Stationery Office, 1956.

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lies with the non-mechanized foundries, of which there is a relatively large number. In these, the general practice is to knock-out at the position at which pouring is done. Some experimenting has been done, instances of which are given below, but many firms say that they have not the necessary resources to indulge in experiments, although they are prepared to do something once they have learned what will prove effective and economic."

One firm tried a degree of centralization and team-working, instead of the traditional method by which each moulder does all his own operations from sand-treatment through to knock-out, but production dropped considerably; when a man does all his operations himself, he sets his own pace of working. Another firm obtained a quotation for a system of localized exhaust ventilation, one head for each moulder's position. The scheme, as first drawn out, was submitted to the British Cast Iron Research Association, and amendments were required, particularly in sizes of trunking; the firm proceeded with the scheme at an estimated cost of £2,500. Another firm experimented on the same lines and a local exhaust unit was ordered. This firm also tried centralizing the knock-out, but found that the amount of handling was so great that it was impossible to run the system economically. In another foundry, the proposal was for a canopy over each moulder's stall, with a fan in the upper right-hand corner drawing the air and dust away from the worker along an inclined plane. A small foundry has been experimenting for some time, and has now installed small roller conveyors at about 3 ft. above floor level, on which the moulds are placed and poured. The moulds are then pushed to a knock-out point where upward exhaust is applied. This firm makes small goods, and knocks out very quickly after pouring.

It is difficult to summarize the position about knock-out operations. Some firms, probably most, still knock-out on the foundry floor where casting takes place. The provision of special knock-out stations which can be provided with exhaust ventilation has been widely discussed. The more progressive firms, thinking along lines of further mechanization, have experimented, or are arranging to do so, with plans for centralized knock-outs associated with further mechanization. In some foundries where big castings are handled there are constructional and other difficulties in providing any central position for this work, while some small foundries plead that lack of floor space and the rate of casting makes it uneconomic to make any change. Damping to keep the dust down is resorted to in several cases and knock-out frequently takes place when only the persons actually doing the knock-out are present. Other firms are spending money on improving the general ventilation, but sufficient attention is not always paid to the provision of air inlets to balance the extraction at the new roof ventilators which are being fitted.

The following describes a general arrangement which might well be adaptable to many foundries. Several roller conveyors converge on to one which leads to a vibrator. Powerful exhaust is provided at the side of the vibrator, so that the ducting does not obstruct access for removal of the casting by overhead crane. Removal of the steam and dust has been found to be fairly complete.

On the use of wet methods, the following is of interest. In one foundry where large numbers of big cast iron pipes are made, difficulty has been encountered in the suppression of dust generated in the de-coring of the pipes. The cores are very hard and quantities of fine dust are produced in digging them out. An experimental high-pressure water jet is to be tried as well as a wet de-coring bar. It may be possible to use the wet de-coring bar from the beginning of the de-coring at each end of the pipe and to use the high-pressure water jet to clear the centre of the pipe.

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Dressing and Fettling Operations.

In these operations, the reduction and control of dust has been considerably improved and, by separation of the processes, the number of workers exposed to dust has been reduced. The reports do not indicate any great difficulty in the separation of processes as required by the Regulations.

Considerable advance has been made in the fitting of efficient exhaust ventilation at pedestal grinders and swing-frame grinders. The use of specially-designed fettling benches with exhaust ventilation has increased and there seems no reason why, in the course of a year or two, considerable progress should not be made. The fitting of dust control apparatus to portable tools such as abrasive wheels, discs and brushes has been a considerable problem, but during the year some progress was made and, since the end of 1955, further developments have led to the view that this problem is capable of solution. Time is, however, required for the development of universally satisfactory devices.

Bathing Facilities and Clothing Accommodation.

It is important that the progress made in the provision of these amenities should be realized, and for that reason I quote figures obtained for December, 1955.

Total number of foundries	1,850
Number where there is full compliance	709
Number where compliance is in progress	691
Number where nothing has been done	389

In the remaining 70 cases exemption from the Regulations is under consideration, and in some cases exemption has been granted. It will be noted that the figures quoted are those for the end of 1955; since then further progress has been made. The progress achieved has not been without considerable difficulty and expense. The standard attained in many cases has been high.

Difficulties have been greatest in small foundries in which space cannot easily be spared and where there are surrounding properties, closely adjoining, which prevent expansion. Some large firms have delayed until the last moment the expenditure for special buildings to house the facilities, but several firms were in course of erecting such buildings at the end of the year. In these, provision has been made for changing rooms, locker accommodation, wash basins and shower baths. The question of what constitutes adequate and suitable facilities for taking shower or other baths has given rise to much controversy.

In some foundries, the interest of the workers in the bathing accommodation is only half-hearted and only a small number use the existing baths. When the firms are asked to provide more accommodation, they argue that there will be no demand for it and that the expenditure will be wasted. However, where a firm provides good shower bath accommodation, experience shows that the number of users will, as a rule, gradually increase. It is often a question of change of habit, that is to say, as to whether workers are going to spend twenty minutes' bathing time at home or in the foundry baths. Possibly the housewife may exercise her influence in favour of the foundry baths. Many workers play games and welcome a bath after the match before they go home. The same principle applies after work, and once the bath habit has been formed, it will continue. Several managements have visited local pit-head baths in search of useful ideas; advice has also been given by firms who already possess shower bath accommodation.

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General.

Some Inspectors report outstanding changes. An excellent example of progress is shown in the case of a large foundry in the Midlands, where 200 persons are employed. The foundry is within the precincts of one of the largest factories in the District, and where the standards of compliance with the Factories Acts are generally of the highest. When the Regulations first came into force, several meetings were held with the higher management to discuss the implications of the Regulations. It was clear that full compliance with the Regulations was going to be a very costly matter indeed. The firm then decided to replan the layout of the whole foundry, to incorporate the most modern equipment and to mechanize as far as possible. This year marks the end of the installation period. The total estimated cost is about £120,000, although not all of this, of course, will have been incurred in order to comply with the Regulations. The firm now have a fine modern foundry, more or less completely mechanized; there is a water-jet cleaning system for the larger castings and for the others, automatic knock-out with complete enclosure and dust extraction plant; fettling benches are provided with mechanical exhaust ventilation. In fact, there is so much air movement that a recently installed panel-heating system is now insufficient and is in process of being augmented. A new ablution block has also been completed, with one shower for every ten persons. The showers are proving extremely popular, and the firm propose to provide additional showers and clothing accommodation should the present installation continue to be used to capacity. Provision for such an extension was made in the design of the block.

It is as well that I should report on some difficulties which have added materially to the work entailed in achieving compliance with the Regulations. Many foundries are severely handicapped by unsuitable buildings and inadequate space. Unfortunately, foundries appear on a list of dirty and noxious (and, therefore, undesirable) trades issued to local planning authorities some years ago, with the result that foundries wishing to move and to rebuild find it extremely difficult in some areas to find any authority prepared to have them. Some trouble has been taken to convince one County Planning Authority that a modern foundry need be no detriment to an industrial area, but some other authorities still persist in their dislike of them. Other difficulties arise because areas in which some foundries have existed for years have been designated as residential, and the firms can neither extend on their present sites nor get help to move elsewhere. One District Inspector laments that, in consequence, there is no foundry in his District where all the latest developments can be seen and that if only there were one such to which planning committees could be invited, the way of the foundry occupier wanting to move might be somewhat easier.

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PART IV. HOURS OF EMPLOYMENT

CHAPTER 21

Hours of Employment

General Observations

Serious manpower shortages, consequent on full employment, were experienced by all industries, except the cotton industry, where as the result of some recession there was short-time working and some redundancy; workers affected were, however, quickly absorbed in other industries.

The exceptionally long hot summer added to the difficulties of the seasonal trades such as the making of ice-cream, ice-cream wafers and mineral waters, photographic developing and printing, and laundries and dry cleaning; in addition, seasonal workers were not readily available.

The basic week remained one of 44-45 hours worked in five days, but considerable overtime beyond the basic week was worked. Sunday work by men was widespread, and some illegal employment of women and young persons on Sundays took place. On the whole, workers are not disposed to work on Saturdays, being quite prepared to substitute Sunday for Saturday, which, they claim, is their only free day for shopping, sport and most forms of entertainment.

The reluctance of many workers to work overtime during the week has also created difficulties, and has been particularly noticeable in some of the London districts where travelling time adds considerably to the working day.

Part-time working by married women is now an integral and indispensable feature of factory life. The hours favoured by married women on day-work are from 9 a.m. to 4 p.m., which permit them to see the children off to school and to be back at home for their return. Morning and afternoon shifts also suit married women as it gives them part of the day for shopping and domestic duties. The most popular system of all is the part-time evening shift between 5 p.m. and 10 p.m.

The actual hours of work continued to be determined by the wishes and convenience of the workpeople available. In consequence, in many factories several schemes of hours operated simultaneously. These comprised normal day-work, with or without overtime, double day-shifts, three shifts, day- and night-shifts, and part-time shifts of one kind or another. Many of these schemes, being outside the provisions of the Factories Acts, were allowed by relaxations in the form of orders under Section 59(1) of the Defence (General) Regulations, 1939.

Much of the illegal employment of women and young persons occurred on Sundays and generally ceased after warning, but it was necessary to take a number of prosecutions, the majority of which were in respect of employment in bakehouses during Friday nights and on Sundays. In mitigation of the offence firms often pleaded not only the shortage of labour but the need to have fresh pies, bread and cakes delivered to the retail shops early on Saturday and Monday mornings to meet the pre-weekend and post-weekend demands. Competition among bakery firms is exceptionally keen, each trying to catch the early shoppers by getting goods into the shops before its competitors.

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One case of the night employment of two boys aged 15 and 16 came to light because the parents of the younger boy became alarmed when he had not returned home before midnight. They informed the police, who at 2 a.m. found the boy in an all-night café near the factory where he worked. He told the police that he had been asked by his employers to work through the night to finish off some safety fireguards, and that he was at that time having a meal interval. He was taken home by the police but the older boy, who was with him, returned to the factory and worked throughout the night and all next day until 4 p.m., a continuous period of 32 hours, apart from meal-times. Another case was that of a boy of 15 employed in the repair workshop of a long-distance road transport firm. From time to time, after having worked the whole day in the factory, he was sent out on long journeys to act as driver's mate if the regular mate failed to report for duty. On the day this was discovered he had returned with the motor lorry at 2 a.m. and started work in the repair shop at 9 a.m. on the same day.

All Divisions report on contraventions of Section 1 of the Employment of Women, Young Persons and Children Act, 1920; children of compulsory school age have been employed in factories after school hours, on Saturdays and during school vacations, particularly during the summer holidays. Such employment was more prevalent in seaside resorts than in other parts of the country, no doubt due to the increased demand for labour in seasonal trades. Inspectors report that such illegal employment was usually due to ignorance on the part of the employers as to the law on the subject, rather than to any deliberate attempt to violate the law. County by-laws regulating the employment of children of school age usually list certain trades which are unsuitable for children, but seldom make any reference to the fact that the employment of children in factories and industrial undertakings is prohibited. Employers are only too glad to avail themselves of the services of these children, not only to meet immediate production requirements, but in the hope that they will take up permanent employment with them on leaving school. These cases sometimes come to notice as the result of accidents. In one such case reported, a boy of 14 had his foot trapped in a conveyor at a cider-making press and in another, a boy, also aged 14, had the end of a finger trapped in a baling press.

This chapter is normally limited to the hours worked by women and young persons, but it may be of interest to record here that a large firm of iron-founders in the West Midlands, in co-operation with a large firm of con-structional engineers who have operated a similar scheme for years, introduced a special scheme of employment for their old-age pensioners. These are employed in an independent production unit on a day rate of wages arranged between themselves and the management. To avoid the rush hours, they start half an hour later and finish an hour earlier than the rest of the factory, leaving five minutes earlier at the mid-day interval. They are allowed a ten-minute break during the morning and afternoon spells and are provided with a small rest-room for their private use.

Under Section 83 of the Factories Act, 1937, 83 orders allowing the period of employment to start before 7 a.m. (but not before 6 a.m.) were issued during the year, of which 62 were renewals of orders previously held. The hot summer accounted for some of these orders in processes such as chocolate coating, biscuit filling and pottery glazing, which have to be done in the cool of the morning. The majority of these orders, however, are required to allow boys under 16 years of age to work on the morning shift, where two-shift or three-shift systems operate. In other cases, the 6 a.m. start is necessary to suit the hours worked by men.

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The Employment of Young Persons (Glass Containers) Regulations, 1955 (S.I.1955, No. 274).

These Regulations came into operation in March, 1955. They apply to factories in which glass bottles or glass jars are manufactured by automatic or semi-automatic machines and enable male young persons aged 16 and over to be employed on shifts in consecutive weeks between 12 midnight and 6 o'clock in the morning provided they are not employed during those hours on more than twelve days in any period of twenty-eight consecutive days.

Special Schemes

Schemes under Emergency Powers

Indicative of the ever-increasing industrial activity throughout the year is the following Table, which gives the number of emergency orders and permissions in force under Section 59(1) of the Defence (General) Regulations, 1939, as continued in force by the Supplies and Services (Continuation) Orders.

TABLE 36

SPECIAL SCHEMES OF HOURS OF EMPLOYMENT

Orders and Permissions in Force	February, 1955	May, 1955	August, 1955	November, 1955
Day-work Schemes and Part-time Evening Employment	1,798	1,836	2,129	2,338
Shift Work	364	362	369	353
Totals	2,162	2,198	2,498	2,691

At the end of November, 1955, the total of 2,691 had exceeded the total for the previous November by 327. This increase was mainly due to the issue of permissions for part-time evening employment, but it also included some part-time evening work with Saturday morning work, extended day-work and shift-work.

As in former years, the sharp rise from May onwards was caused by the issue of orders in respect of factories where the statutory overtime under the Factories Act had been exhausted. Not only did a greater number of firms exhaust their statutory overtime before the end of the year, but many of them did so much earlier in the year than formerly. Relaxations under emergency powers were therefore necessary to enable them to maintain production important to the economy of the country. In most cases the working week, with overtime, averaged 50 hours or less, and this extension did not therefore result in exceptionally heavy overtime being worked.

Orders under the Defence Regulations have been made to allow double day-shifts which are outside the provisions of the Employment of Women and Young Persons Act, 1936; many shift systems, for one reason or another, are now arranged between 7 a.m. and 11 p.m., whereas under the 1936 Act they have to be worked between 6 a.m. and 10 p.m.

Applications to introduce schemes involving the night employment of women were generally refused; exceptions were made, however, during the summer season in the case of some fruit and vegetable preserving factories to prevent wastage of the large quantities of fruit and vegetables which were ripening all at once owing to the hot summer. Towards the end of the year, exceptions were made in a few cases where alternative male adult labour

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was not available and the product was vital to the country's economy. One of these cases was that of a steelworks where a large extension, containing newly-installed and expensive plant which had to be worked continuously day and night, was brought into operation but sufficient men could not be found to work the continuous three-shift system necessary.

Most of the remaining night-work orders have been operating since the war and relate to iron and steel mills and glassworks where the processes are necessarily continuous, and shortage of male adult labour persists.

In some steelworks, the Continental four-crew three-shift system, which has been operating in automatic and semi-automatic glassworks for many years, is now being introduced. Over a period of four weeks, the average working week on this system is one of 44 hours. The system includes Sunday shifts, and here again, where male young persons aged 16 and over are involved, special permissions are necessary.

The Factories (Evening Employment) Order, 1950

Part-time evening shifts have become firmly established in a large number of industries and, as the increase in the number of such permissions shows, are steadily extending to others. Saturday morning work by those employed on evening shifts is now being permitted under special emergency orders in several factories. Reports from all over the country confirm that this system of work has been of immeasurable benefit to industry at a time when the manpower resources of the country were strained to the utmost. Without these evening shifts, many firms would be quite unable to work to their full productive capacity. Industries subject to seasonal pressure have, owing to this system, been able to obtain the output required without making unduly heavy overtime demands on their day workers or having recourse to the special overtime provisions of the Factories Acts. While women on part-time evening shifts are generally employed on productive work, such as light assembly work, packeting, etc., many are now being employed on cleaning-up processes, such as those in bakeries, where baking utensils, tables, etc., are cleaned when the day staff has finished work.

Provided the factories are within easy travelling distance of residential areas, there appears to be no scarcity of applicants for part-time evening shifts.

As has already been stated, many women who work on these part-time evening shifts are now also working on Saturday mornings. These women, having time to do their shopping during the week, do not have the same objections to Saturday morning work as have those workpeople employed full-time.

The Employment of Women and Young Persons Act, 1936

During the year, 157 permanent and 16 temporary authorizations were granted; 58 authorizations were revoked, mainly because either they had not been used during the statutory period of 24 months or they were no longer required. A total of 1,479 authorizations, of which 7 were for temporary periods, were in force at 1,178 factories at the end of November, 1955. This was an increase, over those in force at the same time last year, of 126 permanent and 11 temporary authorizations. This increase occurred mainly in the textile industry, although the number of authorizations operating in the engineering industry also continued to increase. The number of authorizations would probably have been higher had sufficient labour to man two-shift systems been forthcoming, for several firms had to abandon two-shift projects for this reason.

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The Hours of Employment (Conventions) Act, 1936

An automatic sheet glass works in the South of England, which had been closed for some time, was reopened during the year to deal with pressure of orders. Sufficient labour, however, could not be recruited for the operation of the four-crew three-shift 42-hour week system required under this Act. They had perforce to begin with a three-shift system of at least 48 hours a week, but by the end of the year they had obtained the additional men necessary to comply with this Act.

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PART V. WELFARE

CHAPTER 22

Welfare

Washing Facilities

Improvement in the provision of washing facilities was reported from all areas. A high standard is now generally accepted as a necessity for new factories and this is particularly evident on trading estates and in the new towns. There were, however, still cases in which the facilities provided were inadequate. Sometimes, where increases in personnel have taken place, it has been found that no allowance had been made for such expansion. Many architects and managements have consulted the Department during the planning stage and thus avoided subsequent trouble and unnecessary expense. Some local authorities require to know that the washing facilities, in common with other requirements, are in compliance with the Factories Acts before passing factory plans.

The differing attitudes of occupiers and architects were often illustrated, particularly in the case of small factories. One Inspector reports, for example, the case of two small factories which were inspected prior to occupation. One was a garage where about ten persons were to be employed. The building was newly erected and was receiving the finishing touches. Although central heating was installed, there was no provision for hot water at the single wash basin. The occupier promised to rectify this immediately. In contrast, the second factory, where about twelve persons were to be employed, had an excellent washing and sanitary block, which included two wash basins and a shower bath, all with hot and cold water.

Among illustrations of the high standard of facilities in new factories was the following. " In the spacious washrooms of a carpet works both wall basins and circular spray basins have been installed. The walls are tiled throughout and provided with numerous mirrors ; the floors are covered with red asphalt. A glazed cubicle has been provided for an attendant in the men's room ; the women's room communicates directly with a rest room and an ambulance room."

Some Districts reported that whenever opportunity arose for making small extensions or for reconstructing buildings, occupiers tried to provide good washing facilities. This enlightened attitude, however, is unfortunately not yet by any means universal. For example, two firms, employing 500 and 100 workers respectively, were claiming to comply with the Acts by providing buckets of hot water on the shop floor. Neither firm had any spare space but, later, each had cleared a space and installed rows of basins with hot and cold water, liquid soap, hot-air driers and towels. The facilities were being used before the installations were quite completed.

The majority of workers appreciate good arrangements for washing and where wash places are conveniently sited they are well used. Of two comparable engineering works, one has troughs in the main shop and these are regularly used by large numbers of workers. The other has the same amount of accommodation, beautifully kept, but located near the main gates, and this is hardly ever used. Another firm had erected, some years ago, a series of small washing blocks, separate from the main workrooms, in various parts

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of the factory area. These have proved very unsatisfactory, supervision has been difficult, there has been some abuse and it has been difficult to keep them clean. The firm has decided to experiment with the trough-and-spray type of wash basin situated in the workrooms. Reports of abuse of fitments are, in most areas, becoming less frequent, although most disheartening and reprehensible instances of careless usage and even wilful damage and pilfering were found during the year. Some managements have difficulty in stamping out the use of the communal bucket of cold water, even where adequate facilities are available. Inspectors, however, report that the difficulty is considerably reduced when the washbasins are kept reasonably clean. The cleaning of the washing facilities is a problem which managements must solve if the best use is to be made of the accommodation they have provided. If it is no one's duty, then cleaning is left undone. Decorative tiling of walls and tiled floors, which are now frequently found in new washrooms, not only give an attractive appearance, but facilitate cleaning. Some Inspectors express surprise that more use is not made of smooth-surfaced washable material or washable paint behind basins placed against walls.

Difficulties, which will gradually disappear with the implementation of slum-factory clearance schemes, are encountered in congested city areas, where so much of a building has been let off to different occupiers that there is no room to instal separate washrooms, and the plumbing arrangements preclude the provision of wash basins in the workrooms.

In some rural areas, which obtained main water supplies during the year, immediate improvements were effected. There were also improvements in areas still lacking piped-water. For example, a works engineer provided a 40-gallon open-ended drum fitted with an immersion-heater. The drum is filled by hand each morning and the warm water for washing is much appreciated. At another works, buckets were replaced by basins fitted into wooden frames ; the workers said the basins were much preferable to buckets and they take turns in keeping their new basins clean.

On some smaller building sites, buckets are still being used, but the larger sites have ablution blocks with hot and cold water. Some excellent washing accommodation has been seen at premises on docks, where it could not be statutorily required.

The provision of shower baths is reported to be greatly on the increase, not only in industries or processes where baths are required by law. The showers are well used and much appreciated, especially where suitable changing space and accommodation for clothing (both clean and dirty) while bathing has been provided. The latter is an important matter which is apt to be overlooked. At a brewery employing 50 men, a new welfare block, which includes wash basins and a shower bath, is extremely well patronised and cared for by the workers, and the shower is used on Sundays as well as during the week. Another firm allows the workers' families to use the showers at the week-ends. At one coke works, the showers were so popular that extra baths had to be installed ; at another, about 90 per cent of the workers use the baths. At a medium-sized engineering works, where trouble had been experienced with dermatitis, two showers were provided adjacent to the ambulance room, so that their use could be under supervision. The showers have helped to hold the incidence of dermatitis in check. In a factory using inks and colours, special rubber shoes have been provided to prevent the men's feet from becoming stained and to protect them against the cold of the tiled floors.

Means of drying the hands is still a problem to many managements and there are varied views on the subject. The cotton towel continues to be favoured by many firms and some have set up their own laundries for washing

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towels and also, in some cases, overalls. Others have the matter under consideration. In very many cases towels are not replaced nearly often enough. In some areas, increasing use is made of towel-supply services. Paper towels are becoming more popular, but sufficient care is not always taken to ensure that their use does not result in floors being littered with dirty wet paper. Hot-air driers do not seem to be popular, although many Inspectors are of the opinion that they are the answer to the dirty towel problem.

Liquid soap is superseding bar soap and is more favourably received. The method of storing the liquid soap in a central reservoir and bringing it to the basins by means of branch pipes provided with dispensing valves is becoming more common.

Clothing Accommodation

The general picture is one of small advances. The provision of adequate and suitable accommodation for clothing is still regarded by many employers and employees alike as one of the "non-essentials". At the present rate of progress it will be some time before it can be said that the position is everywhere satisfactory.

Inspectors report that the trend during the year has been to provide the clothing accommodation near to the workplaces. As frequently mentioned in these Reports, experience has shown that workers are extremely loth to leave their outdoor clothing out of sight and also to queue up to get it. As in the case of washing accommodation, arrangements necessitating a detour on the way to the factory gate are highly unpopular. Even where good cloakrooms were available, cases were again reported of coats hanging over chair backs, on nails near the workbenches or on stanchions where they almost touched the machines and were exposed to oil-fume and swarf. In one factory clothing was draped over the transformer. At another a worker hung his coat within an area having large notices prohibiting entry because of the presence, in a store below ground, of a Cobalt 60 isotope. He had put his coat there for years and was not going to change his habits. Immediate action was taken in both these cases.

In a number of new factories, cloakrooms have been provided for each department. As a part of a major reconstruction, an engineering works laid out its workshops in such a way that, on entering, the workers pass into a cloakroom and then to the time clock. Washing fountains are placed next in order of sequence so that, when leaving work, a man may conveniently wash, clock-off, collect his clothes and leave. In some shipbuilding yards, where centrally situated cloakrooms had been little used, accommodation has been provided in each department of newly-erected shops. Excellent cloakrooms have been installed in many of the larger factories in the lighter industries and they are well patronised. In the heavier industries, lockers at convenient points were commonly found. Cloakrooms partitioned off from the workshops by glass panelling, and without an attendant, seemed popular with workers. Inspectors report that cloakrooms have been better used when arrangements have been made for the security of belongings by installing pull-up racks, by locking the doors or by appointing an attendant. In a new town, a type of coat-hanger incorporating a basket which can be locked met with workers' approval. The locking of cloakroom doors has to be carefully watched. In a works with an extensive cloakroom on the first floor, the Safety Officer found that the door at the end remote from the attendant's niche had been locked to prevent unauthorized entry. There was risk of serious trouble in the event of fire or of panic exit for any other reason. The lock was replaced by a crash-bar fastening and the attendant was made responsible

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for opening this door before lunch and at finishing time. An Inspector found that the additional accommodation required at one factory had been provided in the shape of a rack placed across the opening to an emergency exit. The rack was swiftly removed.

Inspectors report that some modern lockers are too small to allow adequate circulation of air. They also point out that many industries can, and do, make lockers or other suitable accommodation from materials readily to hand. There have been many improvements, in the form of cupboards or "robes", in the woodworking trades, and in engineering and other works good use has been made of available material. In a large enginering works, racks are provided in each shop; hardboard partitions are fitted to the top and sides and draw-curtains at the front. Tubular heaters the full length of the rack are placed at a low level for drying the clothing when wet. This arrangement has proved very popular and clothing is no longer found lying about the shops.

Lockers are apt to be used as dumping places for discarded articles of all kinds. Some firms require them to be periodically emptied and left open. Anything found in them is destroyed and the lockers are thoroughly cleaned and disinfected.

Arrangements for drying wet clothing are still often unsatisfactory and may be non-existent when the central heating is not in use. The usual remedy is the provision of tubular electric heaters, which can be either permanent fixtures or, in the case of portable stands and racks, plugged into conveniently-placed sockets. Some firms are experimenting with sheet-metal convection plates in an effort to improve the drying efficiency of these heaters. A method of panel radiant heating was also seen.

More interest in clothing accommodation is shown by women than by men. Objection was raised to a new cloakroom separated from a messroom by a 7 ft. high partition; the women said their coats would smell of fish and chips. Having their belongings in handbags in the workrooms, instead of in coat pockets, makes women less anxious about possible pilfering. More firms are now providing suitable accommodation within workrooms for handbags, so that they will not be laid on machines, on workbenches or on the floor and possibly cause accidents.

Managements employing married women realize that the arrival at work of shopping bags and baskets is inevitable, and are accordingly arranging that these, too, be suitably housed.

In the matter of clothing accommodation, as in the case of other requirements of the Act, architects are both highly praised for good industrial planning and, in some cases, strongly criticized for their surprising shortcomings. The usual fault is failure to allot sufficient space, whether the accommodation is to be in separate rooms or within the workshops.

Seating

In new factories and in industries where work is normally done seated, the seats now being provided are of good standard and design and many are excellent. On the other hand, old customs die hard and there is still considerable apathy and also prejudice among employers and employees alike on the question of seating in those processes and types of work hitherto carried out standing. Nevertheless, when managements have, possibly in the face of opposition, provided really good facilities for sitting, the workers have soon come to realize the benefits arising therefrom and have shown appreciation.

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The question of the suitability of seats in relation to the worker and to the job, particularly as regards backrests and footrests, is still a big problem in many factories. In similar works and on identical processes it will be alleged in one firm that backrests inconvenience the workpeople, while in another, all the workers will be found using seats with backrests. In a boot factory, where there is a training school, the girls are trained to use backrests, so that they have become accustomed to them by the time they go into the workrooms on production. The older workers will still not be parted from their stools and boxes if they can possibly help it. They find that a change of habitual posture is inconvenient at first.

During the year, opposition was diminishing to the idea that, wherever practicable, arrangements should be made to do work seated. Many more instances were noted of seats being specially designed to enable employees, who formerly stood, to work using a seat. One firm, making woven labels for clothing, provided specially high chairs (tubular metal with padded leather seats and wooden backrests) from which each weaver can watch for breakages at his four narrow-fabric looms. Another firm installed specially high seats, with backrests, for workers at warping and polishing machines respectively, to give them a good view of the threads. The latter firm also provided low chairs to suit the height of the machine for workers "topping" cotton reels. Jute factories have now installed seats running on rails for drawing and ingiving. At this work the warp beams are suspended from a low gantry. On either side of the beams are seats running on 20 ft. long rails. The frames are of metal construction with wooden seats and backrests, both being adjustable. They have been in use for some time and have given great satisfaction. Formerly the women sat on small stools or boxes, which meant a great deal of straining and moving. Watch-making firms have provided sliding seats for various operations, so that they can be done with the minimum of effort. Sliding seats are much appreciated at conveyor production lines and, in one case, for work on four adjacent machines. At a large factory which produces crankshafts, a seat has been provided for the first time for work at an inspection table. For this job, lateral movement is essential, and, of two sample seats obtained, the type chosen is a chair which runs on rails let into the floor, with arrangements to prevent the chair overturning. One worker commented that he wished he had had the seat "ten years ago". Another process where progress has been noted is that of core-making in foundries. Various types of seats were seen, including hinged seats similar to those on textile speed frames, fixed to the benches where the cores are made.

There are still many cases where the comfort of the workers could be improved by the alteration of plant. For example, in a metal-box factory it was noticed that the pedals of several power presses were too low, and one worker had tried to remedy this by placing a brick on his pedal. This served to drive home the point being made by the Inspector, namely, that suitable alterations to machines and other plant would assist in the seating problem. This fact has again been pointed out with regard to the height of tables and the arrangement of work upon them. In the inspection department of one factory it was observed that all the workers were standing, although, as the works engineer indignantly pointed out, there were many chairs stacked in the room. Obviously, the workers stood because the layout was poor. Old tables, with deep aprons and work stacked high upon them, effectively prevented any attempt to do the jobs seated. For a relatively small cost, e.g., by cutting knee-room in the aprons and arranging trays of work on a semi-circle principle, the unused chairs could have been brought to play their proper part in the factory.

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It has been traditional in the lace curtain mending trade for women to sit on very low, backless stools with their knees almost up to their chins and the work spread out over their knees and gripped between themselves and the stools. A few years ago, the Lace Federation Research Council recommended a particular style of industrial seat, with a backrest, adjustable to low positions. Many firms have now provided these and, if properly used, they greatly improve the sitting posture. In one factory where the women were very conservative in outlook, the manager some years ago was convinced that they would not change to this chair. In 1955, it was found that some of these chairs had been obtained and were being used by the younger workers, although the older ones were still sitting on the backless stools.

An Inspector describes the exceedingly unsatisfactory posture taken up by many workers in the cutlery trade. Certain grinding wheels, on which scissors are ground, are known as "humpers" because of the crouched position in which workers sit over their wheels and which tends to produce spinal curvature even in the straightest back. One firm of tool manufacturers modernized its polishing shop; the spindles were placed on benches and the workers were provided with chairs with backrests and used the old stools as footrests. The change has resulted in a much better posture, which the workers have come to appreciate.

An industry which has clung to the time-honoured buffet is the pin-setting trade, and it is pleasing to report that several conversions have been effected. The work is purely sedentary and experience has shown that objections to a seat with backrest were merely based on prejudice and the question of expense. A particularly good effort was made by the foreman in one of these works, where men were employed. He ingeniously made use of strips of plastic material, which is used in the trade as a foundation for dabbing brushes on wool combs. The plastic is about ¾ in. thick and can be moulded by heat. Strips were moulded to a suitable backrest curve and attached to the existing stools on metal pillars. The men were delighted with the improvement. A similar use of materials available in the workshop was seen in a factory making brake linings, where men are employed on sedentary work, drilling and countersinking finished brake linings. Following a suggestion that the seats should be fitted with backrests, the works manager took several of the largest brake linings, which are of suitable dimensions and curvature, and attached them to the existing stools to make admirable backrests.

In the pottery industry, the increasing degree of mechanization may allow many more jobs to be done seated. For example, some of the automatic glaze-spraying machines are now fed by one worker, who can sit at the feeding point; formerly a person had to stand to operate a spray gun. One firm has modified its towing-machine controls so that they can be operated either from the sitting or the standing position and has provided industrial-type chairs with backrests for the operators. Some biscuit brushers are still to be found using the traditional three-legged stool, but most firms have provided low chairs with backrests.

Concern has been shown in regard to the seats provided for crane-drivers. One Inspector reports: "The worst seating that has been noted has been that provided for overhead crane-drivers. In so many cases the cabs are out of sight and in many instances the seats are improvized; sometimes loose stools and boxes covered with sacks have been seen, although for this type of work it is essential for the crane-driver to have complete control of his crane and to be able to watch his load. Improvements are essential. It is a problem which will have to be tackled by the crane-makers in order to provide

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proper seating and to reduce fatigue and risk of accident. On some modern cranes of overhead type and on some travelling jib cranes good seating is provided."

Inspectors again stressed the value of consultation with the workers in the matter of seating facilities, and several examples were given of the successful results of such action. One concerned a clothing factory which gradually replaced stools with excellent seats and at the same time carried out large-scale reorganization involving the introduction of a better conveyor-system and also of a large new section in which girls work at individual sewing benches. Here, the type of seating best suited to the work was gone into most carefully before reorganization started and individual opinions were asked from the girls working on each different process. The result has been entirely successful. Another Inspector remarked that the provision and design of suitable seats appears to be largely a matter of common sense and that it was satisfactory to find it dealt with in this way rather than as mere compliance with legal requirements. An outstanding example of this kind was found at a factory where about 60 workers, nearly all women, were employed on paper-bag manufacture and where the manager had given the question of seating special attention. A seat was provided for nearly every job and was of such a height and in such a position that the operative accepted and used it as readily as she accepted the operation itself. Some of the seats were fitted quite high up at the side of the machines, so that the machine-minders could watch the work without strain and, in one or two cases, a corner of the seat had been cut away to allow it to be fitted in beside the frame of the machine in just the right position. Backrests were provided in every case and where a fixed footrest was not practicable the manager had provided slightly sloped blocks of wood — this was his only failure; the girls continued to use the flat reels of paper which they selected from the stores. Footrests in general have received too little attention. Reports from many areas indicate that they are usually non-existent or consist of a non-adjustable narrow board or bar which affords a "perch" rather than a "rest" for the feet. Often, in order to get the necessary purchase for the job, the worker makes his or her own footrest out of material which may be conveniently available.

Although much progress has been achieved, it continues to be slow. Many occupiers still consider well-designed seats to be an unnecessary luxury instead of a valuable element in both the welfare and the "productivity" of the worker. Older supervisors are sometimes prone to consider good seating to be "coddling". One Inspector quotes an interesting illustration. "At an engineering works the job of dipping metal rods in cleaning fluids was carried on intermittently in the stores. No one had given much thought to this job, as it was not on a normal production line and it had been customary for it to be done standing. When walking round the stores, it was noticed that the job was being done by a cheerful West Indian who had found himself a stool, placed it on a box and perched himself on it. The foreman looked rather acidly at him and said, 'Are you tired?' The answer came immediately. 'No, I am sitting so that I don't get tired.' The reply was an excellent one and put the matter in a nutshell."

Canteens

The year under review was a critical one for most canteens, because the continuing shortage of trained catering workers, the increased wage rates for canteen staff and the higher cost of many raw materials strained the resources of the canteens generally, so that considerable skill and initiative had to be exercised in order to provide reasonably priced meals.

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The first full year since 1939 without food restrictions of any kind presented an opportunity for wholly competitive buying, an opportunity which was sometimes lost because those concerned lacked the ability to buy skilfully and profitably.

The general picture of the extent to which canteens were used changed a little during the year, and increased prices sometimes resulted in a reduction in the number of main meals sold. The few closures, which mainly took place owing to lack of patronage, were offset by the number of new canteens and the reopening of others at the request of the workers.

Hygienic standards continued to improve; there was greater interest in correct methods of washing-up and many firms installed sterilizing equipment. Very attractive colour schemes were seen in many dining rooms and the addition of curtains, plants and flowers gave a touch of homeliness. On the other hand, there is room for improvement at some dock and shipyard canteens, where the general effect is one of drabness; the type of building construction makes it difficult to keep these canteens attractive, or even reasonably clean.

Appropriate arrangements for providing food at work are required by Special Regulations for the jute industry, clay works and building operations. With one or two exceptions, where space is limited, the standard of premises and furnishings of canteens in jute factories is well maintained. In clay works, the standards vary considerably. Some progress was made in the provision of better furnished and more comfortable messrooms, but, in general, the workers themselves seem to require little more than facilities for tea-making and for warming food. Where there is a further demand, it is usually for snack meals. In building operations on long-term contracts many improvements were noted; canteens were of a more permanent structure and, where finish on walls and floors was smooth and where adequate washing-up facilities had been installed, a good standard of cleanliness was maintained. The use of bottled gas instead of solid fuel also contributed to the improved cleanliness. On smaller sites reports showed that messrooms were frequently of poor structure, with rough floors, and were furnished with uncomfortable chairs and bare wooden tables which were not thoroughly cleaned.

The Canteen Advisers continued to maintain contact with Technical Schools and other institutions engaged in training persons for canteen work. The shortage of well-trained persons for the various grades of canteen work is undoubtedly having a serious effect on the efficient operation of industrial canteens.

There were many requests for advice on managerial and financial problems and the series of charts on canteen planning, staffing and equipment, menu planning, portion control and costing prepared within the Branch have been in considerable demand.

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PART VI MISCELLANEOUS

CHAPTER 23

Textile Piecework Particulars

THE work of this Branch of the Inspectorate becomes more exacting as new systems of piecework payment are introduced into the textile industry. Each system calls for a careful scrutiny by the Inspector to enable him to determine "such particulars of the work to be done by each person employed as affect the amount of wages payable", as required by Section 112(1)(d) of the Factories Act, 1937.

Industrial consultants are engaged in practically every branch of the textile trade from the fibre stage to the finished fabric. In addition to replacing straight piecework systems, time-study methods are being introduced into departments where time-rates previously operated. The continued labour shortage in the textile industry has without doubt influenced many firms to introduce production bonus schemes and time-study methods of payment in an endeavour to obtain the maximum output from the available labour force.

The carpet section of the industry has perhaps been the most conservative in its attitude to work-study methods. Most carpet manufacturers have, until recently, been content to pay straight piecework rates which have been established over the years. The usual method of fixing rates seems to have been the rough basis of allowing a worker to earn what was considered a fair wage for an expected production. Most of the firms have modernized and extended their plants since the war. Wide Spool Axminster looms are now largely used for making seamless Axminster carpets, to the exclusion of "Setting Looms" used for the making of the Chenille type. The setting process requires two weavers for each loom and the production cost is therefore lower in the case of Spool Axminster weaving, which requires only one weaver per loom. In order to lower costs still further and to increase the rate of production, certain manufacturers have fixed piece rates by time-study methods. It has also been found advantageous to foster methods of incentive payments which induce workers to increase production in the spinning and finishing processes of this industry. It seems likely that, in the not too distant future, time-study methods of rate-fixing will be more widely used in the carpet trade as a whole.

Ever since the Cotton Manufacturing Commission System (known in the trade as C.M.C. System) of payment was introduced, manufacturers have had difficulty in maintaining many of the weft package lengths specified on the weavers' Beam Data Cards. In the past year, however, the irregularities have been mainly confined to cop weft. This would indicate that where pirned weft is used manufacturers are now exercising the care necessary to ensure that pirns do not contain less yarn than the length stated and thereby to safeguard the weavers' earnings. Several check visits had to be made to some firms where discrepancies of from 100 yards to 250 yards were noted in the specified cop lengths. Often a length would be reduced, but, at the next visit, the Inspector would find that cops of the same count from the same spinner were again shorter than stated. One of the manufacturers concerned decided, when making tests, to make an allowance of 5 per cent to cover future variations. The other firms have made arrangements to check each delivery of yarn and adjust the Beam Data Cards where necessary. The cost of working this system of payment is undoubtedly increased through the inability or

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unwillingness of certain spinners to co-operate with manufacturers in their attempts to standardize cop lengths. Manufacturers complain that spinners seldom comply with their requests that cops of any one count should always be of the same size and consequently contain the same length of yarn.

Payment under the C.M.C. System can if desired be made by means of a straight piecework rate in pence per 10,000 or 100,000 picks. To the piecework earnings the usual payment for lost time is added. It is rather surprising that this method is not more widely used, as constants can be worked out for any given loom speed from which the rate is easily calculated. Once ascertained, the constants remain standard unless there is an alteration in the rate per hour. From this constant, a simple calculation will give the rate. It would appear that by this straight piecework method of payment weavers can more readily ascertain the amount of their earnings, as it is not necessary for them to know the Attained Efficiency. Where it has been put into practice it seems to have proved satisfactory to the manufacturer. Further, the furnishing of a definite piece rate at the commencement of each working week fully meets the requirements of the Act. Where, however, only the Starting Efficiency is stated, it is not possible for the weaver to calculate her earnings until the Attained Efficiency is obtained at the end of the week. Whatever the system, a pieceworker is entitled to know the piece rate if this can be established. The worker can then at any time calculate the amount of his or her earnings.

It has been noticed on numerous occasions during the year that sufficient care was not being exercised by manufacturers in ensuring that the cloth width and length particulars furnished to weavers were correct. At one factory, a cloth was found to be on average ½ in. wider than described. The management had evidently been aware of the wrong description, as it was stated that there had been a reduction in the number of the ends for the more recent warps and that pieces woven from these warps should measure the stated width. No piece, however, could be found which measured to the description. There were over 100 looms weaving this cloth and the weavers' earnings were adversely affected by 1¼ per cent. The particulars of the cloth width and the weaving rate were corrected and weavers fully recompensed for all pieces woven. The amount of back-pay was £37 3s. At three other factories, where cloths were found to be ½ in. to 1 in. wider than described, amounts of £1 17s., £3 5s. and £2 14s. were paid to weavers as back-pay.

Serious inaccuracies were noted in the cloth lengths furnished to weavers at a cotton weaving mill. Seven different sorts of cloth were found to measure from 1 per cent to 3 per cent longer than the described length on the weavers' cards. The manager was under the impression that there was a standing instruction that any overlength of 2 per cent or more should be paid for, but the Inspector found no such payment being made. In any event, such an arrangement could not be accepted as it would imply that there was a tolerance of 2 per cent, which was obviously not permissible. The length descriptions and weaving rates were amended and weavers were recompensed for previous losses to the extent of £9 18s. At another factory, £3 10s. was paid in back-pay to weavers for losses in earnings resulting from one sort of cloth being 4 per cent longer than described.

When checking a weaving rate it was found that 2½ per cent had been deducted for ring weft. On the weft being examined it was seen that although it was spun direct on to the pirn it did not qualify for the 2½ per cent deduction, because the yarn was not spun on a ring frame. The manager verified this with the spinner. The rates were increased accordingly and £7 11s. was repaid to the weavers concerned.

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Checking of weaving rates forms quite a large part of the Inspector's work and there were many instances of rates being found incorrect, most of which arose in consequence of arithmetical errors. At one factory, the rates for four sorts of cloth were found to be incorrectly stated on the weavers' cards as a result of such errors. The rates were revised and £5 2s. was paid to weavers as recompense. There were also numerous rates incorrectly furnished because of wrong percentage additions or deductions made for different factors affecting the rates. At one factory, the rates for five cloths were adversely affected by such incorrect percentage adjustments having been made for one or more of the following factors: cloth width, high or low picks, pick finding, and coarse twist. When rates were consequently corrected, £4 3s. was paid in back-pay to the weavers concerned. Another firm, who had just commenced to make a spun rayon cloth which was quite new to them, had omitted, by oversight, to make the appropriate 30 per cent addition for these yarns. Fortunately there were only three looms weaving this fabric and back-pay amounted to £1 5s.

At three factories where furnishing fabrics were being made from coloured rayon warps, rates were found to be incorrectly furnished to weavers because the actual sized length of the warps had not been taken into account. The firms were using nominal or ordered lengths for weaving price purposes. The yarns had been stretched in sizing and the actual lengths were approximately 4 per cent more than the nominal lengths, resulting in a corresponding loss to the weaver. The firms were under an erroneous impression that, as the weavers were paid according to pick counter readings, it was not necessary to use the actual sized lengths when calculating the rates. All rates were corrected immediately and weavers recompensed.

The description of particulars of work by means of symbols is not permissible. Nevertheless a number of cases were noted during the year where symbols were being used with the object of preventing the mixing of two or more qualities of the same counts of yarn. Inspectors appreciate the manufacturer's desire to obviate mixed yarns in fabrics and make suggestions to overcome these difficulties. At one rayon factory, it was observed that a punch-hole system was in use for registering weights of yarn processed by the winders, with each punch-hole representing 56 lb. weight. Several lots of work were checked by the Inspector, who found that the majority weighed 56 lb. each, while others varied in weight, to the disadvantage of the operative. It was explained to the manager that the particulars of work must be furnished in writing and that, in consequence of the variation in the weights, the punch-hole system could not be regarded as giving compliance. He immediately gave instructions for written particulars to be supplied.

During the year, instances were noted where particulars of work were not satisfactorily furnished to winders in the cotton trade. This seems to have been particularly evident where winders were being supplied with full cases of yarn. Unknown to the management, certain winding overlookers had taken it upon themselves to supply written particulars of the net weights of the yarn some short time after the yarn was wound. This was usually two days after the work had been given out. At one factory, the winders were not receiving even these particulars until the end of the week, when they were given a summary of the yarn weights. It was arranged in all instances that winders should be supplied with written particulars of the counts and the gross weight at the time the work was given out and later, when the yarn had been wound, they would be given details of the tare weight of the case and net weight of yarn.

A worsted spinning concern in Yorkshire, whose methods of payment have their basis in time-study, recently introduced two interesting innovations. A

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Differential Allowance is now made in the form of additional allowed minutes to any worker who can perform two operations. This is the first allowance of this nature noted in the textile industry and no doubt it will enable the firm to make fuller use of its labour force. In the winding section, where the number of bobbins per cone or cheese is a factor in determining the rate, a counter which may be used by the winder, if desired, for verification purposes, has been provided for each spindle. This is typical of this firm, who go to great lengths to ensure that their workers thoroughly understand their systems of payment. They also, by means of durably mounted tables and ready reckoners, provide the workers in all sections with facilities which make for easy calculation of their earnings.

In the Scottish hosiery trade there appears to have been a substantial increase in the number of outworkers. One small firm in the North had 50 outworkers. Particulars of work and rates of wages are invariably furnished satisfactorily to hosiery outworkers.

CHAPTER 24

Industrial Health and Safety Centre

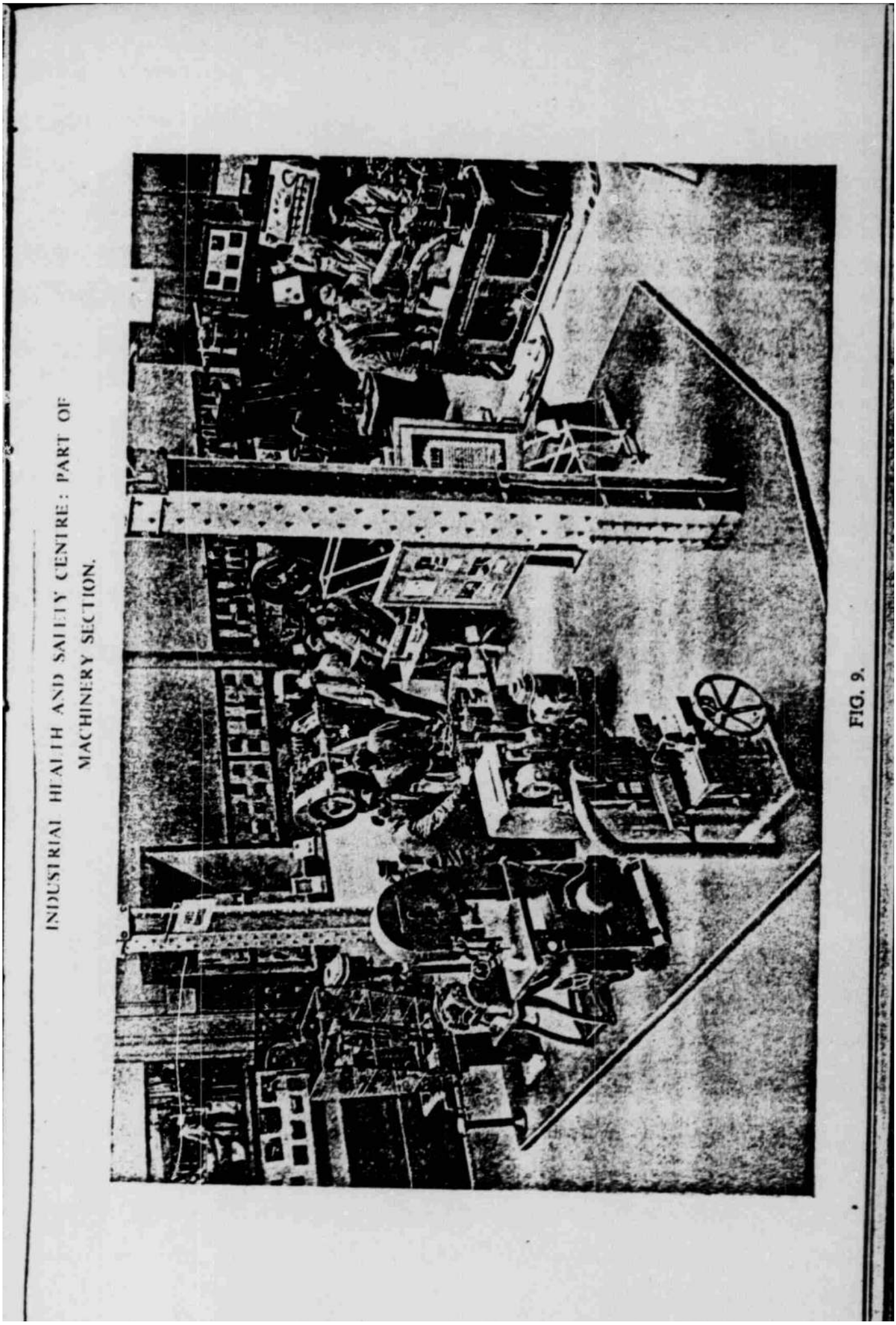
FOR some time, the old title of "Museum" had been considered in various quarters as a misnomer, and this year was memorable in that the name was changed to the present title of Industrial Health and Safety Centre. The official renaming ceremony was performed in March by the Minister, then Sir Walter Monckton, and was attended by representatives from the Ministry, the Ministry of Works, the Institutions of Mechanical, Civil and Electrical Engineers, Employers' Associations and the Trades Union Congress. This occasion marked not only the renaming of the Centre, but the completion of a very extensive programme of reorganization and redecoration which has been carried out since I last reported at length on the work of the Centre. A new centre-piece, for use as an assembly point for visitors and as a focus for special exhibitions, has been completed. This, with its illuminated transparency of an industrial scene, gives an impressive and pleasing effect on entering the Centre. Further improvements in layout and presentation were effected. Groups of machines and some large exhibits have been painted in different colours and this, while giving form to the layout as an exhibition, is, at the same time, indicative of what can be done in a factory. A simple type of fluorescent lighting, with the addition of special spot-lights, has improved the illumination and general appearance of the large part of the ground floor which it serves. Again with the object of improving the presentation of exhibits and also of conserving space, new types of display tables and photographic panels are taking the place of the old. In addition to the repainting of the ground floor and gallery, the bare boards of the ground floor were covered in red linoleum, with plinths in blue for the display of exhibits.

The Centre also continued to add to its usefulness by increasing the number and the variety of exhibits. In this matter firms were ready, as always, to co-operate by lending items of interest and even by making up small displays.

Some 80 new exhibits were obtained during 1955, and many photographs illustrating a wide range of subjects were added to the collection.

There were over 14,000 visitors during the year, while the number of organized parties was 418. In both cases the figures represent an appreciable

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INDUSTRIAL HEALTH AND SAFETY CENTRE: PART OF MACHINERY SECTION.

FIG. 9.

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INDUSTRIAL HEALTH AND SAFETY CENTRE: PART OF MACHINERY SECTION.

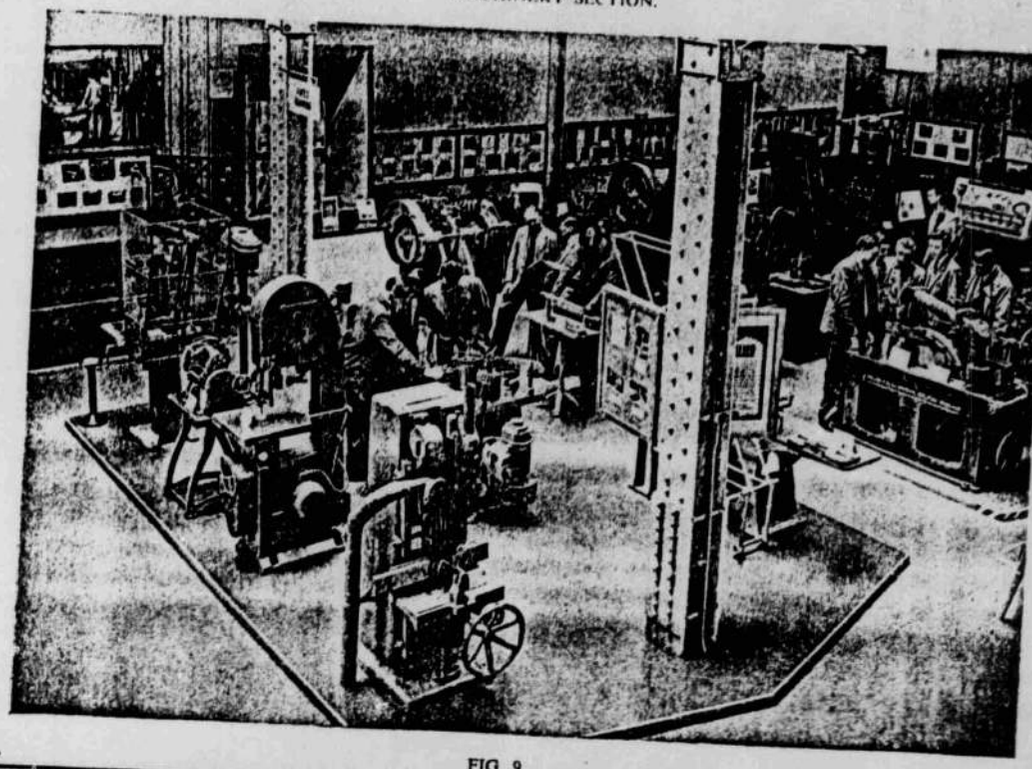


FIG. 9.

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INDUSTRIAL HEALTH AND SAFETY CENTRE: PART OF WELFARE SECTION.

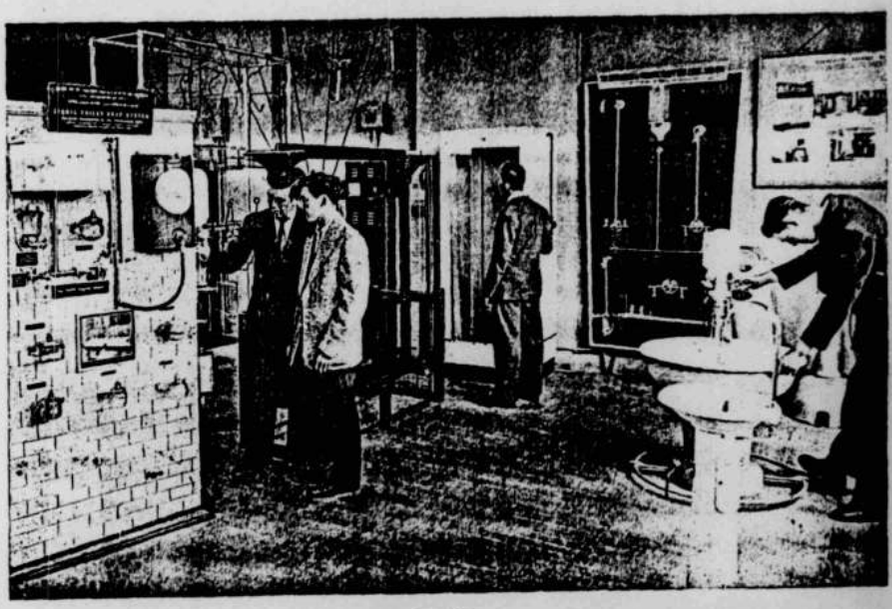


FIG. 10.

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increase over those for the previous year, the increase in the number of parties being as much as 30 per cent. The numbers in each party ranged from two or three to 160. The peak periods for visitors were in March and November.

This year the Centre received visitors representing a greater variety of industries and interests than ever before.

Senior officers of the Royal Electrical and Mechanical Engineers, who were to be in charge of large army workshops employing mainly civilian workers, spent a whole day at the Centre and were given lectures and talks in addition to practical demonstrations.

There was a large party from the Electrical Trades Union, and two of H.M. Electrical Inspectors of Factories helped to make their visit valuable. Another party of ten shop stewards was sponsored by the Amalgamated Union of Foundry Workers; these men were naturally interested in the special exhibition which had been staged to illustrate methods of compliance with the Iron and Steel Foundries Regulations, 1953.

The London Transport Executive sent their Medical Officer and Nursing Sister with a party of twelve foremen from various garages. Their problems included heating, and the use of inflammable solutions, while the Medical Officer was also particularly interested in dermatitis risks.

The Royal Arsenal sent chargehands, foremen and maintenance fitters, who were particularly interested in ventilation and temperature, with special reference to some of the hazards arising in their work.

Again this year, certain firms chose a particular day of the week on which to send their parties of managerial staff, foremen, safety committee members and apprentices and continued these weekly visits until all concerned had had the opportunity of coming. This method stimulates the interest of each party in rotation and provides considerable discussion at subsequent meetings at the factory. Naturally, each group often finds something new or different and when all the personnel have visited there is little that has not been seen by representatives of that particular works.

Six parties, composed of supervisory grades, fitters and members of the newly-formed safety committee, were sent by a large sugar confectionery firm. From a chemical firm came a party organized by a shift-foreman and consisting of members of his shift. It was pleasing to learn that the initial impetus had come from the workers themselves.

Sixteen executives from the Ministry's training centres, who were studying at a College of Commerce, were instructed in safety matters concerning the various machines which they used.

The legal profession was represented by solicitors. Many agents from Insurance Companies came in search of technical information, while architects sought information on all points in the Factories Acts which would require consideration in the building and layout of new factories. Student doctors and nurses from some of the teaching hospitals and schools came in organized groups, as part of their training in the subjects of industrial diseases and the health hazards of industry.

Sections of the Centre are shown in Figs. 9 and 10. Fig. 9 shows part of the machinery section of the ground floor. Members of a visiting group are discussing the merits of various guards for the cutters of a vertical spindle moulding machine, and points in connection with a power-feed circular saw. Welfare amenities form a large part of the exhibits in the gallery, a corner of which is shown in Fig. 10. As the photographs indicate, the younger generation was well represented among visitors to the Centre, mainly by parties of apprentices.

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CHAPTER 25

Staff

THE TOTAL number of Inspectors in post at the end of the year was 361, the authorized strength of the Inspectorate being 381. The fact that the former figure was precisely the same as that at the end of 1954 shows the continued difficulties in recruiting and retaining staff. Although the loss during the year by retirement accounted for only 7 posts, there were 11 resignations in the Class II and IB grades ; the other two losses were due to a transfer to another Government Department and to a death. Prior to 1955, it was the practice to hold two competitions a year, but after the winter competition in January, 1955, it was decided to arrange for Selection Panels to sit periodically and deal with applications as soon as possible after receipt, and, as a result of this, after June, panels interviewed candidates on eight occasions before the end of the year. As a result of all the competitions in 1955, 137 candidates were interviewed and 29 declared successful, but 3 of these declined appointment. This type of running competition is being continued in 1956 in an endeavour to fill the existing vacancies.

Pressure of work on the staff has been extremely heavy throughout the year and I should again like to express my personal appreciation of the loyal manner in which the whole Inspectorate and their office staffs have responded to the many calls made upon their time. I am satisfied that the year has been one of solid achievement, in which all have played their part. The volume of work and its detail, by reason of changes and developments in industry, is continually growing. The number of power factories under our jurisdiction is increasing and building operations have been particularly active during the period under review, calling for more and more attention by District staffs. In addition to the essential work of inspection *per se*, an increasing number of industrial and area accident prevention committees have asked for lectures and advice, and more time has had to be devoted to meeting, advising and helping a record number of overseas visitors from no less than 26 different countries in Europe, Asia, Australia and Africa, who wished to study and get information on the work of the Factory Inspectorate. Many of these visitors were attached to the Department for periods of from one to four months. Separate programmes have frequently been arranged for them, including a course of lectures by Deputy Chief Inspectors and Specialist Inspectors, followed by visits with District Inspectors and their staffs to many factories in various parts of the country. The Department is specially indebted to the many firms who have so generously provided facilities for these visitors to see modern standards of safety, health and welfare in their respective factories. The visitors have all expressed their appreciation of the time and help given to them and there is every reason to hope that the experience so gained will result in the improvement of working conditions, particularly in those countries which are now developing industrially. In some cases it has been possible to include overseas visitors at our own training courses and the Royal Society for the Prevention of Accidents has also most kindly arranged for some to attend one or other of the courses on Industrial Safety Training which are organized periodically in conjunction with the Factory Inspectorate.

There has been the usual close collaboration with other Government Departments, and I should like particularly to record my thanks and those

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of the Inspectorate to the Government Chemist, the Department of Scientific and Industrial Research, the National Physical Laboratory, the Safety in Mines Research Establishment, the Joint Fire Research Organization, the Ministries of Supply and Fuel and Power, the United Kingdom Atomic Energy Authority, also to the Statistical and other branches of our own Ministry, for the very ready and helpful manner in which they have responded to our requests for information, advice and practical help covering a wide variety of problems arising from our work in the industrial field.

The preparation of this report entails a great deal of collation and detailed work, editorially and otherwise, and I desire to place on record here my very best thanks to all of my colleagues who have assisted me so willingly in this work.

I am, Sir,

Your obedient Servant,

G. P. BARNETT.

Acknowledgments

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APPENDIX I

Number of Factories, Accidents and other Particulars tabulated according to Factory Inspectors' Districts, 1955

Districts	Factories with Mechanical Power	Factories without Mechanical Power	Docks, Wharves, Quays (S.105)	Warehouses (S.105)	Building Operations (S.107)		Works of Engineering Construction (S.108)		Premises under S.154	Firms Registered under Lead Paint Act, 1926	Accidents	
					(6)	(7)	(8)	(9)			Fatal	Non-Fatal
					Sites	Contractors	Sites	Contractors				
(1)	(2)	(3)	(4)	(5)					(10)	(11)	(12)	(13)
South Eastern Division												
South London	2,366	175	28	27	252	312	10	11	10	551	1	1,478
Croydon	3,121	275	—	17	642	927	12	12	24	252	7	1,136
Richmond ..	2,848	222	8	19	486	609	36	36	17	866	3	1,251
Woolwich	3,241	337	75	40	381	560	4	5	9	312	7	3,725
Southwark	2,359	139	138	241	110	113	2	2	2	345	10	1,832
Maidstone	3,134	272	80	40	447	560	37	40	14	894	8	2,242
Brighton	2,985	288	40	26	324	387	9	9	13	869	4	868
Total ..	20,054	1,708	369	410	2,642	3,475	110	115	89	4,089	40	12,532
Central Metropolitan Division												
East London ..	3,202	206	158	187	240	270	7	7	—	67	7	1,327
N. E. London ..	2,789	167	4	33	490	552	31	31	6	505	4	1,240
Central London ..	1,836	168	17	143	381	509	9	9	—	28	5	591
Finsbury	3,160	229	4	92	258	283	4	5	3	444	5	578
West Ham	1,360	95	67	82	227	276	22	23	—	80	15	3,578
S. Essex	3,107	172	54	17	523	569	23	23	7	220	12	3,920
Ipswich	2,670	279	16	43	372	456	10	10	15	331	5	1,480
Total ..	18,124	1,316	320	597	2,491	2,915	106	108	31	1,675	53	12,714
Southern Division												
West London ..	4,146	730	54	62	583	753	5	5	7	32	10	2,211
Ealing	3,066	155	9	21	603	757	38	41	11	542	8	3,095
N.W. London ..	3,513	448	—	74	214	286	19	19	6	63	3	895
Paddington ..	2,977	303	6	14	235	247	2	4	1	60	8	1,419
North London ..	3,434	318	8	65	371	500	9	10	—	642	3	1,975
Reading	3,575	387	—	41	401	522	43	52	28	356	14	2,341
Southampton ..	3,444	425	160	98	593	714	44	44	9	830	5	1,878
Portsmouth ..	2,149	209	49	28	473	581	62	63	12	636	6	1,719
Total ..	26,306	2,975	286	403	3,473	4,360	222	238	74	3,161	57	15,533
South Western Division												
Bristol North ..	2,950	234	61	210	489	565	25	25	24	442	12	2,707
Bristol South ..	1,918	151	17	64	343	401	31	36	14	457	3	1,385
Gloucester	1,532	135	20	41	313	404	13	14	9	287	4	1,043
Exeter	2,110	233	23	14	190	264	17	18	17	597	4	607
Plymouth	2 822	352	97	86	282	395	11	11	10	491	5	1,288
Yeovil	1,621	133	14	31	96	113	7	9	9	205	1	472
Total ..	12,953	1,238	232	446	1,713	2,142	104	113	83	2,479	29	7,502
Wales Division												
Newport	1,129	102	13	18	278	308	23	23	8	150	9	2,707
Cardiff	2,147	190	18	73	340	468	24	26	12	221	9	2,889
Swansea	1,568	241	27	44	433	614	25	26	11	195	14	3,727
Carmarthen ..	1,365	209	13	48	250	312	34	34	5	132	2	1,240
Wrexham	2,165	187	41	20	207	294	29	31	19	281	6	1,247
Total ..	8,374	929	112	203	1,508	1,996	135	140	55	979	40	11,810
South Midland Division												
Birmingham North ..	1,762	82	—	12	271	476	6	9	—	202	8	1,626
Birmingham East ..	1,616	105	2	18	456	580	17	17	—	142	3	1,988
Birmingham South ..	2,135	201	6	33	357	543	13	13	13	186	6	1,497
Birmingham West ..	2,452	131	1	8	358	541	2	2	2	138	5	1,649
Coventry	2,095	138	12	32[1]	230	444	22	25	8	426	5	2,350
Worcester	1,940	179	17	42	1,052	1,184	25	27	11	361	2	864
Total ..	12,000	836	38	145	2,724	3,768	85	93	34	1,455	29	9,974
West Midland Division												
Wolverhampton North	1,789	70	9	17	246	287	6	6	5	132	4	2,267
Wolverhampton South	1,774	72	7	20	235	270	10	11	—	106	3	1,413
Walsall	2,313	96	12	14	127	164	3	4	4	170	11	2,464
Shrewsbury ..	1,176	113	—	23	106	147	6	6	9	226	3	1,012
Stoke-on-Trent ..	2,092	164	5	28	197	317	3	3	—	229	10	2,562
Derby	2,567	125	—	38	171	246	24	28	10	299	7	2,858
Total ..	11,711	640	33	140	1,082	1,431	52	58	28	1,162	38	12,576

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APPENDIX I—*continued*

Number of Factories, Accidents and other Particulars tabulated according to Factory Inspectors' Districts, 1955—*continued*

Districts	Factories with Mechanical Power	Factories without Mechanical Power	Docks, Wharves, Quays (S.105)	Warehouses (S.105)	Building Operations (S.107)		Works of Engineering Construction (S.108)		Premises under S.154	Firms Registered under Lead Paint Act, 1926	Accidents	
					(6)	(7)	(8)	(9)			Fatal	Non-Fatal
					Sites	Contractors	Sites	Contractors				
(1)	(2)	(3)	(4)	(5)					(10)	(11)	(12)	(13)
East Midland Division												
Leicester	3,741	175	3	114	210	282	11	11	8	443	5	1,531
Nottingham ..	3,024	222	22	94	407	578	21	21	7	187	4	2,026
Lincoln	2,039	132	20	71	363	399	28	28	9	281	2	939
Norwich	2,798	331	92	50	245	322	14	14	15	377	8	1,219
Cambridge ..	1,790	187	1	32	630	787	59	61	9	322	5	725
Luton	3,578	247	2	27	414	763	68	73	20	568	9	2,601
Northampton ..	1,904	88	5	104	241	295	9	12	7	248	4	1,242
Total ..	18,874	1,382	145	492	2,510	3,426	210	220	75	2,426	37	10,283
North Midland Division												
Sheffield North ..	2,206	161	2	23	137	152	1	1	1	118	6	3,223
Sheffield South ..	1,521	78	1	26	146	189	7	5	2	142	3	1,818
Doncaster	2,707	279	50	45	195	238	12	12	12	143	25	5,267
Wakefield	2,044	179	15	65	116	159	3	3	9	198	10	2,037
Huddersfield ..	1,810	88	3	38	133	182	7	7	1	114	8	1,564
Halifax	1,727	51	7	43	143	187	8	8	2	158	7	1,067
Hull	2,372	252	81	117	124	141	5	6	11	191	7	1,867
Total ..	14,387	1,088	159	357	994	1,268	43	42	38	1,064	66	16,843
North Eastern Division												
Leeds South ..	2,762	159	36	42	294	388	15	18	14	241	7	2,866
Leeds North ..	2,643	194	6	41	322	460	26	27	8	140	3	1,193
Bradford	2,723	295	—	124	198	290	1	1	7	212	3	1,581
Keighley	1,187	57	—	23	47	81	5	5	2	127	3	681
Darlington ..	1,225	117	—	15	431	434	45	46	11	170	3	1,871
Middlesbrough ..	1,547	109	28	30	386	771	42	51	5	179	22	4,891
Gateshead ..	2,100	178	51	40	476	691	33	34	6	246	18	5,971
Newcastle	2,673	258	59	106	432	556	37	44	16	303	17	3,820
Total ..	16,860	1,367	180	421	2,586	3,671	204	226	69	1,618	86	22,874
East Lancashire Division												
Salford	1,589	74	24	74	202	281	7	8	2	24	9	2,352
Manchester South ..	2,605	157	18	127	339	455	11	11	1	138	3	1,082
Manchester North ..	2,444	216	—	94	182	245	6	7	3	53	6	1,370
Stockport ..	1,971	113	—	22	174	227	13	15	9	47	1	955
Ashton-under-Lyne ..	1,308	59	1	26	87	152	4	4	—	112	5	1,041
Oldham	1,636	109	—	48	35	96	6	6	—	147	8	1,541
Rochdale	1,286	34	—	36	117	166	3	8	1	142	2	1,243
Bolton	2,345	206	—	64	308	506	2	2	5	237	10	2,974
Total ..	15,384	968	43	491	1,444	2,128	52	61	21	900	44	12,558
North Western Division												
Liverpool South ..	1,667	190	162	339	136	200	11	12	4	266	15	3,246
Liverpool North ..	1,891	108	7	522	151	212	9	10	7	329	3	2,327
West Cheshire ..	1,440	132	50	24	312	451	25	32	5	344	10	2,234
Warrington ..	1,880	102	41	58	301	367	24	25	11	251	13	3,973
Wigan	1,433	126	3	14	490	692	10	11	6	174	1	1,839
Blackburn	1,496	77	3	21	91	150	2	2	3	179	2	1,413
Burnley	1,534	75	2	14	97	131	1	1	1	150	3	1,122
Preston	2,545	197	25	36	262	365	6	11	11	270	10	1,847
Barrow	1,231	110	16	16	76	91	16	16	7	130	6	1,032
Carlisle	1,187	128	13	24	127	146	13	13	8	89	7	1,262
Total ..	16,304	1,245	322	1,068	2,043	2,805	117	133	63	2,182	70	20,295
Scotland Division												
Glasgow West ..	2,024	175	76	96	182	379	15	19	4	99	15	4,284
Glasgow Central ..	2,772	239	62	106	157	252	15	19	7	113	7	1,641
Lanarkshire ..	2,288	121	—	12	255	416	34	38	13	135	31	3,903
Renfrew	1,778	94	45	33	128	300	21	23	7	107	14	3,131
Ayr	1,773	129	24	17	117	229	20	26	5	136	6	912
Stirling	1,043	111	22	18	175	349	7	8	9	92	8	1,705
Edinburgh ..	3,647	387	20	73	259	426	26	26	19	317	12	2,121
Fifeshire	1,206	61	21	6	171	281	13	13	2	129	8	1,384
Dundee	2,232	163	34	60	112	163	36	39	18	169	1	1,651
Aberdeen	3,739	472	82	53	55	86	32	34	15	193	12	1,474
Total ..	22,502	1,952	386	474	1,611	2,881	219	245	99	1,490	114	22,206
GRAND TOTAL	213,833	17,644	2,625	5,647	26,821	36,266	1,659	1,792	759	24,680	703	187,706

Columns 2 and 3 exclude 51 works forming parts of institutions to which the Factories Act, 1937, is applied by Section 1(and also exclude ships to which the Act is applied by Section 106. They also exclude docks, wharves, quays and warehouse building operations, works of engineering construction, and premises under Section 154 (all of which are shown in columns 4 to 1(railway lines and sidings referred to in Sections 105 to 108 of the Factories Act, 1937, and also homework premises, and factori under the charge of H.M. Inspector of Mines.

Columns 12 and 13 relate to the numbers of persons affected.

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APPENDIX II

ALL Reported Accidents, 1955 ; Industry, Age, Sex

(THE INJURED PERSON IS THE UNIT)

An accident means an accident which is either fatal or disables the workman for more than three days from earning full wages at the work at which he was employed.

Industry	Adults				Young Persons				Totals	
	Males		Females		Males		Females			
(1)	Fatal (2)	Non-Fatal (3)	Fatal (4)	Non-Fatal (5)	Fatal (6)	Non-Fatal (7)	Fatal (8)	Non-Fatal (9)	Fatal (10)	Non-Fatal (11)
TEXTILE										
Cotton	4	1,981	2	2,460	—	152	—	299	6	4,892
Wool, Worsted and Shoddy	7	1,634	1	1,162	—	135	—	258	8	3,189
Flax, Hemp and Jute ...	—	480	—	589	—	60	—	111	—	1,240
Silk, Rayon, etc.	—	496	—	205	—	13	—	32	—	746
Hosiery	—	127	—	152	—	33	—	50	—	362
Other Textiles ... ... (Textile Printing, Bleaching and Dyeing—Shown below)	—	328	—	183	—	29	—	35	—	575
Total Textile	11	5,046	3	4,751	—	422	—	785	14	11,004
NON-TEXTILE										
Clay, Stone, Lime and Cement—										
Brick, pipe and tile making	9	1,799	—	130	—	167	—	32	9	2,128
Other clay, stone, lime and cement	17	1,775	—	35	—	69	—	2	17	1,881
Total	26	3,574	—	165	—	236	—	34	26	4,009
Metals—										
Metal extracting and refining	17	2,171	—	25	—	57	—	1	17	2,254
Metal conversion ...	26	4,388	—	107	—	107	—	8	26	4,610
Iron, steel and other metal rolling	18	6,731	—	363	—	600	—	30	18	7,724
Metal tube making and wire drawing	8	2,324	—	137	—	75	—	17	8	2,553
Metal founding	16	9,020	—	308	—	298	—	32	16	9,658
Metal galvanising, tinning, plating and enamelling ...	2	565	—	115	—	70	—	13	2	763
Total	87	25,199	—	1,055	—	1,207	—	101	87	27,562
Engineering Works (other than Machine Making), Machine and other Tools—										
Marine engine-building and repairing	—	1,291	—	32	—	212	—	1	—	1,536
Locomotive-building and repairing	3	1,706	—	15	1	205	—	1	4	1,927
Other engine-building; transmission machinery ...	2	1,126	—	73	—	47	—	5	2	1,251
Boiler-making	2	1,294	—	19	—	139	—	1	2	1,453
Constructional engineering	8	2,087	—	33	—	225	—	1	8	2,346
Electrical engineering ...	6	4,639	1	1,460	—	269	—	119	7	6,487
Hydraulic, ventilating and pneumatic engineering ...	1	771	—	51	—	68	—	12	1	902
Machine tool and other tool making	3	1,212	—	166	—	136	—	10	3	1,524
Total	25	14,126	1	1,849	1	1,301	—	150	27	17,426
Machinery, Machinery Accessories, etc.—										
Textile machinery and accessories	2	842	—	58	—	54	—	2	2	956
Other miscellaneous machine making	8	2,783	—	207	—	224	—	13	8	3,227
General and jobbing engineering, making and repairing machinery ...	13	6,516	—	581	—	677	—	46	13	7,820
Railway and tramway plant and vehicles	3	3,397	—	55	1	243	—	5	4	3,700
Motor vehicles (other than steam), motor cycles, cycles, carts and carriages	15	7,610	—	629	1	560	—	70	16	8,869
Ordnance and munitions of war	5	2,312	—	613	—	40	—	12	5	2,977
Total	46	23,460	—	2,143	2	1,798	—	148	48	27,549

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APPENDIX II—*continued*

ALL Reported Accidents, 1955; Industry, Age, Sex—*continued*

Industry (1)	Adults				Young Persons				Totals	
	Males		Females		Males		Females			
	Fatal (2)	Non-Fatal (3)	Fatal (4)	Non-Fatal (5)	Fatal (6)	Non-Fatal (7)	Fatal (8)	Non-Fatal (9)	Fatal (10)	Non-Fatal (11)
Non-textile—*continued*										
LIGHT METAL TRADES ...	3	2,355	1	1,444	—	244	1	242	5	4,285
INDUSTRIAL APPLIANCES (locks, bolts, screws, springs, chains, etc.) ...	3	1,111	—	509	—	108	—	56	3	1,784
MISCELLANEOUS METAL TRADES	9	1,994	—	215	—	133	—	33	9	2,375
SHIPBUILDING	43	7,746	—	81	3	573	—	3	46	8,403
AIRCRAFT	3	2,085	—	125	—	66	—	3	3	2,279
GENERAL WOODWORK—										
Sawmills, joinery and general woodworking ...	13	4,390	—	219	2	568	—	25	15	5,202
Box and packing case making	—	237	—	74	—	50	—	10	—	371
Brushes and other special woodware	—	220	—	69	—	34	—	21	—	344
Other builders' materials ...	1	664	—	44	—	37	—	2	1	747
Total	14	5,511	—	406	2	689	—	58	16	6,664
FURNITURE, ETC.—										
Cabinet and chair making, upholstery	—	558	—	85	—	87	—	14	—	744
Other furniture making ...	3	946	—	214	—	73	—	43	3	1,276
Total	3	1,504	—	299	—	160	—	57	3	2,020
POTTERY	3	647	—	374	—	45	—	42	3	1,108
GLASS	1	1,495	—	393	—	145	—	62	1	2,095
CHEMICALS, ETC.—										
Artificial manure ...	1	240	—	6	—	6	—	—	1	252
Coal tar	6	1,383	—	9	—	22	—	—	6	1,414
Other chemicals	32	3,839	—	473	1	76	—	49	33	4,437
Paint, colours and varnish...	1	463	—	78	—	12	—	10	1	563
Total	40	5,925	—	566	1	116	—	59	41	6,666
TANNING, CURRYING LEATHER PRINTING, BLEACHING, DYEING AND CLEANING—	2	605	3	126	—	70	—	25	5	826
Textile printing, bleaching and dyeing	4	852	—	142	—	35	—	25	4	1,054
Cloth finishing, raising, lapping, making-up and packing ...	—	131	—	33	—	8	—	5	—	177
Job dyeing, other finishing, cleaning and dyeing ...	2	76	—	63	—	5	—	16	2	160
Laundries	—	237	—	367	—	30	—	41	—	675
Total	6	1,296	—	605	—	78	—	87	6	2,066
WEARING APPAREL AND ARTICLES FOR PERSONAL USE—										
Tailoring	1	107	—	264	—	29	—	91	1	491
Dress, millinery, underclothing and other wearing apparel ...	3	235	—	547	—	38	—	178	3	998
Boots, shoes, slippers and clogs	—	464	—	206	—	81	—	67	—	818
Total	4	806	—	1,017	—	148	—	336	4	2,307
RUBBER TRADES	6	1,706	—	335	—	49	—	34	6	2,124
PAPER, PRINTING AND STATIONERY—										
Paper, cardboard, and millboard making ...	11	2,947	—	336	—	256	—	100	11	3,639
Letterpress and lithographic printing and bookbinding	—	1,251	—	328	—	126	—	136	—	1,841
Cardboard and paper box making	3	361	—	293	—	28	—	74	3	756
Other printing, photography, etc.	—	450	—	128	—	30	1	47	1	655
Total	14	5,009	—	1,085	—	440	1	357	15	6,891

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APPENDIX II—*continued*

ALL Reported Accidents, 1955; Industry, Age, Sex—*continued*

Industry (1)	Adults				Young Persons				Totals	
	Males		Females		Males		Females			
	Fatal (2)	Non-Fatal (3)	Fatal (4)	Non-Fatal (5)	Fatal (6)	Non-Fatal (7)	Fatal (8)	Non-Fatal (9)	Fatal (10)	Non-Fatal (11)
Non-textile—continued										
FOOD—										
Flour and other milling ...	1	736	—	50	—	21	—	10	1	817
Bakeries	2	1,077	—	889	—	96	—	141	2	2,203
Confectionery (sugar), groceries, etc.	—	977	—	910	—	78	—	167	—	2,132
Other foods	4	2,970	1	1,479	—	143	—	135	5	4,727
Total	7	5,760	1	3,328	—	338	—	453	8	9,879
DRINK—										
Alcoholic	7	1,697	1	542	—	112	1	72	9	2,423
Non-Alcoholic	—	171	—	210	—	31	—	24	—	436
Total	7	1,868	1	752	—	143	1	96	9	2,859
TOBACCO AND MATCHES ...	—	305	—	148	—	20	—	32	—	505
OILCAKE, OIL REFINING AND EXTRACTING	9	1,410	—	86	1	31	—	6	10	1,533
SOAP, STARCH, CANDLES, ETC.	—	320	—	105	—	11	—	18	—	454
FINE INSTRUMENTS, JEWELLERY, SPORTS ARTICLES, ETC. ...	—	857	—	445	—	84	—	77	—	1,463
GAS WORKS	14	3,230	—	27	—	26	—	—	14	3,283
ELECTRICAL STATIONS ...	18	2,473	—	40	—	19	—	2	18	2,534
OTHER MISCELLANEOUS INDUSTRIES	1	636	—	242	—	44	—	29	1	951
Total Non-Textile	394	123,013	7	17,965	10	8,322	3	2,600	414	151,900
Places under ss. 105-108 of the Factories Act, 1937										
DOCKS, SEC. 105	48	7,188	—	31	—	26	—	1	48	7,246
BUILDING OPERATIONS SEC. 107 — Construction ...	124	11,050	—	10	4	529	—	—	128	11,589
BUILDING OPERATIONS SEC. 107 — Maintenance ...	44	2,279	—	5	3	77	—	—	47	2,361
BUILDING OPERATIONS SEC. 107 — Demolition ...	9	417	—	—	—	10	—	—	9	427
WORKS OF ENGINEERING CONSTRUCTION, SEC. 108 ...	39	1,950	—	1	—	22	—	—	39	1,973
WAREHOUSES, SEC. 105 ...	4	1,065	—	103	—	25	—	7	4	1,200
Total places under ss. 105-108 of the Factories Act, 1937	268	23,949	—	150	7	689	—	8	275	24,796
Grand Total ...	673	152,008	10	22,866	17	9,433	3	3,393	703	187,700

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ALL Reported Accidents,
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An accident means an accident which is either fatal or disables the workman fo

Industry	Machinery moved by Mechanical Power												Transport (whether moved by Power or not)		O
	Prime Movers (Steam, Gas and other Engines, Electric Motors) (not electric shock)	Transmission Machinery: Shafting	Transmission Machinery: Belts, Ropes, Pulleys and Gearing	Lifting Machinery	Machine Tools for Metal working: Milling Machines	Machine Tools for Metal working: Power Presses (other than Punches)	Woodworking Machinery: Circular Saws (all types)	Woodworking Machinery: Planing Machines (as defined in Regulations)	Woodworking Machinery: Vertical Spindle Moulding Machines	Woodworking Machinery: Other	Rollers of Calenders, Mixers, etc., (not for Metal or Wood-working) ("Nip" accidents)	Other	Railways (Locomotives & Rolling Stock)	Other Vehicles (excluding Hand Trucks, Bogies, etc.)	Electricity
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Textile															
COTTON	4	2	52	23	—	—	3	1	—	—	49	878	1	67	5
WOOL, WORSTED AND SHODDY	—	1	56	32	—	—	3	2	—	1	57	849	—	52	9
FLAX, HEMP AND JUTE	—	1	7	8	—	—	1	2	—	1	33	345	—	19	1
SILK, RAYON, etc. ...	—	1	6	4	—	—	1	1	—	—	5	93	11	42	2
HOSIERY	—	1	6	1	—	—	—	—	—	—	2	93	—	5	3
OTHER TEXTILES ... (Textile Printing, Bleaching and Dyeing—Shown below)	1	1	8	—	2	1	2	1	—	—	8	135	1	11	2
Total Textile ...	5	7	135	68	2	1	10	7	—	2	154	2,393	13	196	22
Non-Textile															
CLAY, STONE, LIME AND CEMENT—															
Brick, pipe and tile-making	3	—	17	8	—	1	1	3	—	2	1	112	57	262	2
Other clay, stone, lime and cement ...	8	2	10	47	—	2	6	3	—	1	6	122	76	224	10
Total ...	11	2	27	55	—	3	7	6	—	3	7	234	133	486	12
METALS—															
Metal extracting and refining ...	5	1	7	70	1	—	1	1	—	1	—	66	199	79	7
Metal conversion ...	2	2	1	296	1	4	2	1	—	—	7	215	316	134	13
Iron, steel and other metal rolling ...	7	1	7	352	4	5	5	1	—	—	8	555	239	191	31
Metal tube making and wire drawing ...	5	—	2	110	1	7	3	—	—	—	3	344	27	88	9
Metal founding ...	3	1	7	389	4	2	5	8	—	13	2	684	99	259	22
Metal galvanising, tinning, plating and enamelling ...	1	1	1	15	—	2	1	—	—	—	—	62	5	36	1
Total ...	23	6	25	1,232	11	20	17	11	—	14	20	1,926	885	787	84
ENGINEERING WORKS (OTHER THAN MACHINE MAKING), MACHINE & OTHER TOOLS—															
Marine engine building and repairing...	2	1	3	57	6	—	2	3	—	3	—	166	9	42	4
Locomotive building and repairing ...	—	—	2	43	3	1	1	1	1	—	—	161	43	30	12
Other engine building; transmission machinery	1	1	4	33	4	3	1	—	—	1	—	171	6	53	3
Boiler making ...	—	—	2	70	3	1	3	2	—	—	1	122	2	40	2
Constructional engineering	2	—	1	171	2	2	1	1	—	3	1	147	50	79	16
Electrical engineering	2	1	8	80	33	62	20	7	1	3	8	750	14	279	58
Hydraulic, ventilating and pneumatic engineering ...	1	—	1	19	8	4	3	4	—	—	1	130	5	41	1
Machine tool and other tool making	—	—	6	22	28	14	6	3	1	7	1	363	1	39	4
Total ...	8	3	27	495	87	87	37	21	3	17	12	2,010	130	603	11
MACHINERY, MACHINERY ACCESSORIES, ETC.—															
Textile machinery and accessories ...	—	—	10	6	19	1	20	5	—	12	—	182	—	25	3
Other miscellaneous machine making ...	5	—	3	81	26	21	5	7	—	4	1	487	9	113	20
General and jobbing engineering, mak-															

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IX III
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an three days from earning full wages at the work at which he was employed.

Explosions)	Gassing	Molten Metal; other Hot or Corrosive Substances	Other — Machinery not moved by Mechanical Power: Lifting Machinery	Other — Machinery not moved by Mechanical Power: Other	Other: Use of Hand Tools	Other: Struck by Falling Body	Other: Persons Falling	Other: Stepping on or striking against Objects (not included in other Columns)	Other: Handling Goods or Articles in manufacturing or carrying processes (not included in other Cols)	Other: Other	Total All Accidents	Cleaning of Machinery in Motion (included elsewhere in Table) — Men	Cleaning of Machinery in Motion (included elsewhere in Table) — Women and Young Persons	Eye Injuries from particles or fragments thrown off in course of process (included elsewhere in Table)	Eye Injuries—Other (included elsewhere in Table)	Materials or Articles while in motion in a machine (included elsewhere in Table)	Immersion of any part of the body in fixed vessels, etc., containing scalding, corrosive or poisonous fluid (included elsewhere in Table)	Sepsis (included elsewhere in Table)	Accidents Associated with Electricity (included elsewhere in Table)
(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30) (a)	(30) (b)	(31)	(32)	(33)	(34)	(35)	(36)
6	1	50	7	77	224	306	883	682	1,183	388	4,898	52	129	17	55	6	3	398	—
4	1	29	7	14	157	162	597	279	650	225	3,197	93	81	27	18	17	4	303	—
1	1	6	14	12	79	74	135	103	308	89	1,240	2	12	4	5	26	—	104	1
—	2	13	2	8	37	53	141	82	185	53	746	4	5	4	13	8	—	44	1
—	—	4	—	5	19	15	95	29	35	48	362	—	3	4	5	1	—	29	1
2	—	14	—	10	24	37	97	48	121	48	575	13	3	5	5	—	—	30	1
13	5	116	30	126	540	647	1,948	1,223	2,482	851	11,018	164	233	61	101	58	7	908	4
1	—	23	7	20	130	199	256	144	788	83	2,137	9	4	24	16	—	—	99	—
5	1	48	25	16	145	169	226	105	525	97	1,898	9	—	34	38	—	2	69	—
6	1	71	32	36	275	368	482	249	1,313	180	4,035	18	4	58	54	—	2	168	—
9	11	256	16	9	252	179	285	147	563	73	2,271	1	—	75	59	1	1	55	2
21	10	323	26	14	474	534	613	412	997	165	4,636	2	—	152	66	6	3	166	1
22	7	282	37	38	980	756	918	645	2,358	271	7,742	9	4	150	99	61	2	353	2
6	2	84	16	12	158	282	256	196	828	110	2,561	3	1	67	45	33	4	161	3
20	5	1282	53	42	899	962	618	587	3,269	363	9,674	7	4	537	181	1	5	594	3
2	—	94	5	8	33	50	83	56	278	27	765	—	—	33	13	—	4	43	1
80	35	2321	153	173	2,796	2,763	2,773	2,043	8,293	1,009	27,649	22	9	1,014	463	102	19	1,372	12
2	2	32	7	12	231	149	168	146	435	50	1,536	—	—	56	17	4	1	86	3
4	—	39	21	13	332	199	203	149	572	99	1,931	1	—	87	32	2	1	113	3
2	—	14	14	5	101	142	107	89	391	106	1,253	2	1	33	19	10	—	109	1
4	1	33	8	9	189	187	169	126	400	76	1,455	—	—	46	22	3	—	82	—
3	2	49	33	13	223	303	208	196	758	81	2,354	1	—	61	38	5	—	128	3
20	1	224	34	259	417	543	799	596	1,877	369	6,494	11	4	168	152	27	1	445	13
2	—	17	8	12	103	107	69	52	261	45	903	—	1	36	15	8	—	77	—
2	—	21	7	21	134	162	116	101	390	77	1,527	3	—	83	22	12	—	134	1
39	6	429	132	344	1,730	1,792	1,839	1,455	5,084	903	17,453	18	6	575	317	71	3	1,174	24
2	1	10	9	15	81	71	73	42	313	57	958	4	2	21	14	6	—	76	—
4	—	53	25	48	308	387	277	181	987	176	3,235	2	2	163	49	18	2	249	4
24	3	138	55	166	707	793	686	498	2,260	378	7,833	6	3	330	130	30	3	473	9

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Industry	Machinery moved by Mechanical Power												Transport (whether moved by Power or not)		Other	
	Prime Movers (Steam, Gas and other Engines, Electric Motors) (not electric shock)	Transmission Machinery: Shafting	Transmission Machinery: Belts, Ropes, Pulleys and Gearing	Lifting Machinery	Machine Tools for Metal working: Milling Machines	Machine Tools for Metal working: Power Presses (other than Punches)	Woodworking Machinery: Circular Saws (all types)	Woodworking Machinery: Planing Machines (as defined in Regulations)	Woodworking Machinery: Vertical Spindle Moulding Machines	Woodworking Machinery: Other	Rollers of Calenders, Mixers, etc., (not for Metal or Wood-working) ("Nip" accidents)	Other	Railways (Locomotives & Rolling Stock)	Other Vehicles (excluding Hand Trucks, Bogies, etc.)	Electricity	Explosions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(
Non-textile—*continued*—																
Railway and tramway plant and vehicles	4	—	4	70	1	7	32	7	1	9	1	224	148	78	12	
Motor vehicles (other than steam), motor cycles, cycles, carts and carriages ...	17	1	18	119	40	75	19	40	5	21	1	950	14	542	38	
Ordnance and munitions of war ...	4	—	4	44	13	8	9	7	2	1	—	208	115	213	15	
Total ...	46	2	64	495	176	163	107	77	10	49	6	3,371	344	1,264	124	
LIGHT METAL TRADES	2	—	17	22	20	139	3	2	—	—	12	668	9	162	14	
INDUSTRIAL APPLIANCES (locks, bolts, screws, springs, chains, etc.)	—	—	5	24	8	23	3	—	1	1	1	304	7	63	6	
MISCELLANEOUS METAL TRADES ...	4	1	6	67	7	24	1	—	—	2	1	393	41	134	9	
SHIPBUILDING ...	12	—	3	310	5	—	18	13	1	10	1	284	60	132	58	
AIRCRAFT	2	—	—	11	12	2	6	6	1	3	1	177	10	98	8	
GENERAL WOODWORK—																
Sawmills, joinery and general woodworking	9	3	17	70	1	—	1,019	590	185	360	6	110	63	329	6	
Box and packing case making	—	—	1	2	—	1	64	16	1	14	2	26	—	22	—	
Brushes and other special woodwork	—	—	1	1	1	—	23	14	8	15	—	67	4	14	—	
Other builders' materials	2	1	3	9	4	4	3	7	1	4	3	65	5	69	7	
Total ...	11	4	22	82	6	5	1,109	627	196	393	11	268	72	434	13	
FURNITURE, ETC.—																
Cabinet and chair making, upholstery	—	—	1	3	1	1	68	53	48	81	—	49	—	17	2	
Other furniture making	—	2	5	4	—	6	38	34	28	49	20	119	5	61	3	
Total ...	—	2	6	7	1	7	106	87	76	130	20	168	5	78	5	
POTTERY	—	—	4	2	—	1	1	1	—	—	2	64	6	48	1	
GLASS	2	—	3	12	1	—	5	2	—	1	4	76	49	125	—	
CHEMICALS, ETC.—																
Artificial manure ...	—	—	2	3	—	—	—	—	—	—	—	14	10	24	—	
Coal tar	3	1	—	7	—	—	1	—	—	—	2	38	159	64	2	
Other chemicals ...	4	5	6	43	1	1	3	4	—	—	11	213	103	297	19	
Paint, colours and varnish	—	1	2	3	—	—	—	—	—	—	6	24	—	43	2	
Total ...	7	7	10	56	1	1	4	4	—	—	19	289	272	428	23	
TANNING, CURRYING LEATHER ...	—	—	5	7	—	—	1	2	—	—	41	130	2	23	1	
PRINTING, BLEACHING, DYEING & CLEANING—																
Textile printing, bleaching & dyeing	2	3	4	3	—	—	2	1	—	—	36	108	1	37	2	
Cloth finishing, raising, lapping, making up and packing	—	—	1	9	—	—	—	—	—	—	7	15	—	6	2	
Job dyeing, other finishing, cleaning and dyeing ...	—	—	—	1	—	—	—	—	—	—	1	10	—	5	1	
Laundries ...	3	—	6	4	—	—	—	—	—	—	16	108	—	19	1	
Total ...	5	3	11	17	—	—	2	1	—	—	60	241	1	67	6	
WEARING APPAREL AND ARTICLES FOR PERSONAL USE—																
Tailoring	—	—	6	—	—	—	—	—	—	—	—	119	—	5	—	

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—*continued*

Industry, Causation—*continued*

Fires (not Dangerous Occurrences or Explosions)	Gassing	Molten Metal; other Hot or Corrosive Substances	Other: Machinery not moved by Mechanical Power: Lifting Machinery	Other: Machinery not moved by Mechanical Power: Other	Other: Use of Hand Tools	Other: Struck by Falling Body	Other: Person Falling	Other: Stepping on or striking against Objects (not included in other Columns)	Other: Handling Goods or Articles in manufacturing or carrying processes (not included in other Cols)	Other: Other	Total All Accidents	Cleaning of Machinery in Motion (included elsewhere in Table): Men (a)	Cleaning of Machinery in Motion (included elsewhere in Table): Women and Young Persons (b)	Eye Injuries from particles or fragments thrown off in course of process (included elsewhere in Table)	Eye Injuries—Other (included elsewhere in Table)	Materials or Articles while in motion in a machine (included elsewhere in Table)	Immersion of any part of the body in fixed vessels, etc., containing scalding, corrosive or poisonous fluid (included elsewhere in Table)	Sepsis (included elsewhere in Table)	Accidents Associated with Electricity (included elsewhere in Table)
(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30) (a)	(30) (b)	(31)	(32)	(33)	(34)	(35)	(36)
4	—	93	24	12	551	393	393	308	1,124	195	3,704	1	—	154	87	2	2	183	3
73	4	177	59	113	683	731	1,117	678	2,543	717	8,885	3	4	352	211	13	4	764	30
9	2	57	10	35	185	297	502	217	862	138	2,982	1	2	61	37	7	3	92	6
116	10	528	182	389	2,515	2,665	3,048	1,924	8,089	1,661	27,597	17	13	1,081	528	76	14	1,837	52
12	4	103	18	328	205	295	362	354	1,297	222	4,290	13	7	95	67	19	—	362	5
3	1	55	4	57	123	141	129	136	585	104	1,787	1	1	75	34	10	2	220	1
7	2	81	12	42	247	266	184	141	620	62	2,284	2	3	83	38	4	2	150	2
21	13	217	87	29	846	896	1,857	1,058	2,091	387	8,449	—	—	194	133	2	1	363	19
4	—	23	6	34	130	210	488	255	584	199	2,282	1	—	77	46	4	1	158	—
5	—	24	16	28	287	351	381	265	938	129	5,217	13	2	61	31	10	1	244	6
1	—	1	—	5	27	27	24	34	86	17	371	2	2	4	5	—	—	32	1
1	—	5	—	8	18	21	31	24	70	13	344	1	2	5	4	1	1	26	—
1	—	20	6	5	49	66	95	52	226	38	748	3	1	20	13	1	2	45	1
8	—	50	22	46	381	465	531	375	1,320	197	6,690	19	7	90	53	12	4	347	8
4	—	9	1	13	70	40	64	39	134	42	744	1	2	10	15	2	—	49	1
5	—	20	3	26	77	97	167	97	352	51	1,279	9	2	11	18	9	—	84	1
9	—	29	4	39	147	137	231	136	486	93	2,023	10	4	21	33	11	—	133	2
2	1	16	3	20	44	79	211	89	403	110	1,111	2	4	9	3	—	2	74	—
7	1	79	2	10	133	151	235	259	868	66	2,096	—	—	50	28	1	—	145	—
—	1	3	2	4	18	22	55	17	60	10	253	1	—	4	2	—	—	13	—
10	6	113	4	9	145	71	302	106	266	72	1,420	3	—	38	31	2	3	37	1
36	60	465	41	30	258	285	785	311	1,145	239	4,470	15	4	138	135	2	15	189	10
10	2	39	2	8	28	35	99	40	189	17	564	3	1	9	6	—	—	27	—
56	69	620	49	51	449	413	1,241	474	1,660	338	6,707	22	5	189	174	4	18	266	11
11	1	31	3	29	74	40	158	45	180	44	831	7	3	9	10	4	—	58	7
1	2	68	6	8	42	60	218	81	308	51	1,058	8	4	10	20	15	5	50	—
—	—	5	1	3	5	16	31	14	50	12	177	2	—	2	2	2	—	16	—
1	—	13	—	4	10	8	43	18	26	16	162	1	—	2	5	—	—	8	—
1	—	34	1	19	17	44	128	89	136	41	675	2	3	1	5	—	1	42	5
3	2	120	8	34	74	128	420	202	520	120	2,072	13	7	13	32	17	6	116	3
2	—	12	—	35	58	15	110	44	50	34	492	—	4	3	5	—	—	68	—

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Industry	Machinery moved by Mechanical Power												Transport (whether moved by Power or not)		Other
	Prime Movers (Steam, Gas and other Engines, Electric Motors) (not electric shock)	Transmission Machinery: Shafting	Transmission Machinery: Belts, Ropes, Pulleys and Gearing	Lifting Machinery	Machine Tools for Metal working: Milling Machines	Machine Tools for Metal working: Power Presses (other than Punches)	Woodworking Machinery: Circular Saws (all types)	Woodworking Machinery: Planing Machines (as defined in Regulations)	Woodworking Machinery: Vertical Spindle Moulding Machines	Woodworking Machinery: Others	Rollers of Calenders, Mixers, etc., (not for Metal or Wood-working) ("Nip" accidents)	Other	Railways (Locomotives & Rolling Stock)	Other Vehicles (excluding Hand Trucks, Bogies, etc.)	Electricity	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
Non-textile—*continued*—																
Dress, millinery, underclothing and other wearing apparel	—	2	11	2	—	—	1	—	—	—	5	280	—	11	12	
Boots, shoes, slippers and clogs ...	—	—	10	2	—	1	11	—	2	5	1	294	—	17	2	
Total ...	—	2	27	4	—	1	12	—	2	5	6	693	—	33	14	
RUBBER TRADES ...	—	2	4	13	—	—	1	—	—	1	40	262	3	72	3	
PAPER, PRINTING AND STATIONERY—																
Paper, cardboard and millboard making	2	—	18	36	—	1	5	1	—	1	188	259	53	162	8	
Letterpress and lithographic printing and bookbinding	1	1	7	10	—	—	6	2	—	—	59	468	—	59	3	
Cardboard and paper box making ...	1	—	4	4	—	1	1	—	—	2	15	233	—	35	—	
Other printing, photography, etc. ...	—	—	3	4	—	—	4	1	—	1	22	94	—	19	2	
Total ...	4	1	32	104	—	2	16	4	—	4	284	1,054	53	275	13	
FOOD—																
Flour & other milling	1	1	27	24	—	—	1	1	—	—	5	86	14	82	3	
Bakeries	3	—	4	12	—	—	1	2	—	—	55	350	5	94	2	
Confectionery (sugar), groceries, etc. ...	—	—	6	4	1	—	2	—	—	—	14	210	8	61	3	
Other foods ...	2	4	20	16	—	3	5	2	—	1	4	338	22	271	9	
Total ...	6	5	57	56	1	3	9	5	—	1	78	984	49	508	17	
DRINK—																
Alcoholic ...	4	—	5	22	—	—	2	8	—	—	2	140	22	202	4	
Non-alcoholic ...	—	—	3	2	—	—	—	—	—	—	—	47	1	40	—	
Total ...	4	—	8	24	—	—	2	8	—	—	2	187	23	242	4	
TOBACCO AND MATCHES	1	—	2	3	—	—	1	2	—	1	3	57	1	29	—	
OILCAKE, OIL REFINING & EXTRACTING	5	1	4	22	—	—	1	1	—	—	2	46	41	149	5	
SOAP, STARCH, CANDLES, ETC. ...	1	1	1	3	—	—	2	—	—	1	—	31	10	38	1	
FINE INSTRUMENTS, JEWELLERY, SPORTS ARTICLES, ETC. ...	—	1	10	3	13	17	22	11	5	8	7	237	—	42	8	
GAS WORKS ...	21	—	11	19	—	—	2	—	—	—	4	99	105	192	14	
ELECTRICITY GENERATING STATIONS ...	4	1	2	23	—	—	—	2	—	1	—	60	61	90	90	
OTHER MISCELLANEOUS INDUSTRIES ...	1	—	3	8	—	3	4	—	—	1	8	116	18	69	—	
Total Non-Textile ...	180	44	396	3,176	349	501	1,499	893	295	646	652	14,429	2,390	6,671	644	
Places under Ss. 105-108 of the Factories Act, 1937																
DOCKS, SEC. 105 ...	5	—	—	1,256	1	—	—	1	—	—	—	36	432	609	6	
BUILDING OPERATIONS SEC. 107 — Construction ...	141	1	9	255	—	—	46	8	1	4	1	326	33	788	47	
BUILDING OPERATIONS SEC. 107 — M'tenance	3	—	—	10	—	—	1	3	1	2	—	29	1	48	7	
BUILDING OPERATIONS SEC. 107 — Demolition	1	—	1	4	—	—	—	—	—	—	—	10	1	17	1	
WORKS OF ENGINEERING CONSTRUCTION, S. 108	18	—	3	101	—	—	6	—	—	1	—	89	108	182	12	
WAREHOUSES, SEC. 105	—	—	—	40	—	—	2	1	—	—	—	11	34	186	—	
Total places under Ss. 105-108 of the Factories Act, 1937	168	1	13	1,666	1	—	55	13	2	7	1	501	609	1,830	73	
Total, All Accidents ...	353	52	544	4,910	352	502	1,564	913	297	655	807	17,323	3,012	8,697	739	
Total of Non-Fatal Accidents	352	47	542	4,854	351	501	1,561	913	297	654	806	17,283	2,979	8,639	697	
Total of Fatal Accidents	1	5	2	56	1	1	3	—	—	1	1	40	33	58	42	

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continued

Industry, Causation—*continued*

Other																			
Explosions)	Gassing	Molten Metal; other Hot or Corrosive Substances	Machinery not moved by Mechanical Power		Use of Hand Tools	Struck by Falling Body	Persons Falling	Stepping on or striking against Objects (not included in other Columns)	Handling Goods or Articles in manufacturing or carrying processes (not included in other Cols)	Other	Total All Accidents	Cleaning of Machinery in Motion (included elsewhere in Table)		Eye Injuries from particles or fragments thrown off in course of process (included elsewhere in Table)	Eye Injuries—Other (included elsewhere in Table)	Materials or Articles while in motion in a machine (included elsewhere in Table)	Immersion of any part of the body in fixed vessels, etc., containing scalding, corrosive or poisonous fluid (included elsewhere in Table)	Sepsis (included elsewhere in Table)	Accidents Associated with Electricity (included elsewhere in Table)
			Lifting Machinery	Other								Men	Women and Young Persons						
(19)		(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30) (a)	(30) (b)	(31)	(32)	(33)	(34)	(35)	(36)
6	—	21	1	26	70	28	215	86	144	78	1,001	3	—	8	10	1	—	132	1
5	2	9	—	14	73	22	116	56	126	48	818	2	8	14	11	1	—	77	1
13	2	42	1	75	201	65	441	186	320	160	2,311	5	12	25	26	2	—	277	2
4	1	60	9	44	155	200	269	181	654	136	2,130	8	1	28	24	17	2	111	7
2	5	93	35	31	190	294	390	274	1,105	228	3,650	29	6	39	59	15	5	162	4
6	—	33	3	76	58	122	280	170	390	85	1,841	36	26	11	11	1	—	66	1
1	—	7	2	19	23	49	85	58	170	49	759	8	8	5	4	1	—	44	—
4	1	17	—	21	25	46	132	64	172	21	656	8	5	5	6	1	—	21	—
13	6	150	40	147	296	511	1,087	566	1,837	383	6,906	81	45	60	80	18	5	293	5
—	—	5	7	4	24	48	190	53	189	48	818	17	2	3	4	—	—	27	4
3	—	54	1	40	63	139	471	197	569	113	2,205	58	28	7	11	1	—	126	5
1	—	268	1	12	66	127	429	164	596	153	2,132	9	24	10	16	1	1	139	2
1	12	234	13	36	480	317	936	429	1,341	224	4,732	22	20	30	43	—	8	470	2
5	12	561	22	92	633	631	2,026	843	2,695	538	9,887	106	74	50	74	2	9	762	13
3	3	91	8	15	74	169	548	203	770	86	2,432	1	3	18	21	2	3	120	2
—	—	13	—	1	5	31	65	33	161	24	436	—	1	8	9	—	—	24	—
3	3	104	8	16	79	200	613	236	931	110	2,868	1	4	26	30	2	3	144	2
—	—	3	—	7	23	42	78	45	155	51	505	1	4	3	6	—	—	29	1
9	11	76	14	7	104	116	354	130	359	63	1,543	4	—	20	27	1	9	40	2
—	1	26	4	7	21	21	102	35	117	27	454	3	—	7	5	—	2	21	1
6	3	47	2	118	73	96	172	125	325	96	1,463	5	5	37	26	3	2	95	3
22	38	217	29	28	411	216	663	310	600	219	3,297	4	—	65	60	—	9	112	3
3	5	103	26	25	319	187	569	262	497	192	2,352	—	—	41	70	—	1	108	5
1	—	19	5	11	74	64	148	79	248	63	952	6	6	14	20	2	—	52	—
165	228	6181	877	2,188	12,558	13,158	20,711	12,193	42,131	7,733	152,314	389	224	4,011	2,461	384	116	8,987	192
1	1	23	26	9	307	1,012	1,084	592	1,686	202	7,294	2	—	28	60	1	—	156	1
27	15	223	97	33	1,073	1,220	3,309	1,275	2,343	422	11,717	5	—	234	190	1	3	457	1
4	1	49	13	2	219	205	1,126	155	402	125	2,408	—	—	67	50	—	—	114	1
—	—	2	4	—	38	93	158	34	58	14	436	—	—	6	9	—	—	18	—
14	5	25	22	11	194	251	334	145	402	60	2,012	2	1	34	27	—	—	57	1
1	—	7	12	5	29	124	192	106	419	34	1,204	—	—	4	9	—	—	54	1
47	22	329	174	60	1,860	2,905	6,203	2,307	5,310	857	25,071	9	1	373	345	2	3	856	5
25	255	6626	1,081	2,374	14,958	16,710	28,862	15,723	49,923	9,441	188,403	562	458	4,445	2,907	444	126	10,751	201
05	244	6617	1,070	2,372	14,954	16,647	28,604	15,718	49,904	9,433	187,700	561	458	4,445	2,906	443	122	10,751	191
20	11	9	11	2	4	63	258	5	19	8	703	1	—	—	1	1	4	—	10

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AP

ALL Reported Accidents, 1

An accident means an accident which is either fatal or disables the workman for

Division	Machinery moved by Mechanical Power												Transport (whether moved by Power or not)		Oth
	Prime Movers (Steam, Gas and other Engines, Electric Motors) (not electric shock)	Trans-mission Machinery		Lifting Machinery	Machine Tools for Metal working		Woodworking Machinery				Rollers of Calenders, Mixers, etc., (not for Metal or Wood-working) ("Nip" accidents)	Other	Railways (Locomotives & Rolling Stock)	Other Vehicles (excluding Hand Trucks, Bogies, etc.)	Electricity
		Shafting	Belts, Ropes, Pulleys and Gearing		Milling Machines	Power Presses (other than Punches)	Circular Saws (all types)	Planing Machines (as defined in Regulations)	Vertical Spindle Moulding Machines	Other					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
South-Eastern Division.	33	—	38	315	39	33	112	83	26	63	100	1,021	101	729	48
Central Metropolitan Div.	23	3	23	460	16	31	153	95	56	60	24	934	155	788	41
Southern Division.	22	1	50	170	43	71	167	107	51	102	55	1,424	85	702	78
South-Western Division.	35	1	22	126	15	11	100	58	17	44	35	614	104	395	29
Wales Division.	29	5	29	355	12	33	65	32	8	15	20	727	432	504	47
South Midland Division.	6	2	24	150	61	115	75	39	12	31	12	1,340	35	540	44
West Midland Division.	14	1	26	251	24	70	76	56	17	32	33	1,199	187	723	36
East Midland Division.	35	8	35	199	28	23	127	72	28	73	52	1,148	151	628	35
North Midland Division.	24	4	59	549	19	20	121	60	22	48	48	1,755	419	702	53
North-Eastern Division.	40	5	54	665	21	27	165	91	13	52	70	1,873	545	827	104
East Lancashire Division.	15	8	66	186	20	11	75	59	14	26	131	1,439	51	300	49
North-Western Division.	27	7	63	767	19	28	129	68	16	39	93	1,703	348	1,056	70
Scotland Division.	30	7	55	717	35	29	199	93	17	70	134	2,096	399	803	105
Total, All Accidents ...	353	52	544	4,910	352	502	1,564	913	297	655	807	17,323	3,012	8,697	739
Total of Non-Fatal Accidents ...	352	47	542	4,854	351	501	1,561	913	297	654	806	17,283	2,979	8,639	697
Total of Fatal Accidents ...	1	5	2	56	1	1	3	—	—	1	1	40	33	58	42

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X IIIa

alysis by Causation ; Tabulated by Divisions

an three days from earning full wages at the work at which he was employed.

rences or Explosions)	Gassing	Molten Metal; other Hot or Corrosive Substances	Other: Machinery not moved by Mechanical Power: Lifting Machinery	Other: Machinery not moved by Mechanical Power: Other	Other: Use of Hand Tools	Other: Struck by Falling Body	Other: Persons Falling	Other: Stepping on or striking against Objects (not included in other Columns)	Other: Handling Goods or Articles in manufacturing or carrying processes (not included in other Cols)	Other: Other	Total All Accidents	Cleaning of Machinery in Motion (included elsewhere in Table): Men	Cleaning of Machinery in Motion (included elsewhere in Table): Women and Young Persons	Eye Injuries from particles or fragments thrown off in course of process (included elsewhere in Table)	Eye Injuries—Other (included elsewhere in Table)	Materials or Articles while in motion in a machine (included elsewhere in Table)	Immersion of any part of the body in fixed vessels, etc., containing scalding, corrosive or poisonous fluid (included elsewhere in Table)	Sepsis (included elsewhere in Table)	Accidents Associated with Electricity (included elsewhere in Table)
)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30) (a)	(30) (b)	(31)	(32)	(33)	(34)	(35)	(36)
33	13	403	74	208	948	1,072	2,134	1,041	3,079	753	12,572	32	20	225	280	14	8	648	9
39	9	350	71	176	869	1,399	2,174	1,082	3,076	577	12,767	36	12	273	199	14	3	526	23
59	14	519	50	241	1,053	1,694	2,601	1,599	3,746	783	15,590	51	22	327	360	33	15	789	20
16	10	203	36	69	672	637	1,208	544	1,924	575	7,531	26	16	162	109	5	1	461	4
34	19	542	65	150	1,158	1,066	1,767	938	3,126	610	11,850	23	15	268	179	27	5	513	6
47	5	334	61	289	644	859	1,257	787	2,564	615	10,003	14	14	307	219	35	6	812	11
31	11	676	50	181	899	1,321	1,677	976	3,157	825	12,614	12	12	389	190	15	8	683	8
19	26	262	65	154	791	751	1,670	673	2,706	496	10,320	30	18	252	148	27	1	761	20
29	19	646	106	121	1,425	1,548	2,378	1,385	4,633	575	16,909	75	48	501	137	31	10	1,112	13
79	29	788	134	259	2,195	1,834	3,517	1,829	6,772	797	22,960	47	48	603	265	50	16	1,312	45
22	25	425	80	99	863	970	2,139	1,193	3,459	748	12,602	79	102	221	232	48	13	721	3
52	38	719	137	260	1,393	1,653	3,308	1,750	5,546	981	20,365	68	69	416	263	67	26	1,093	19
65	37	759	152	167	2,048	1,906	3,032	1,926	6,135	1,106	22,320	69	62	501	326	78	14	1,320	20
25	255	6626	1081	2,374	14,958	16,710	28,862	15,723	49,923	9,441	188,403	562	458	4,445	2,907	444	128	10,751	201
05	244	6617	1070	2,372	14,954	16,647	28,604	15,718	49,904	9,433	187,700	561	458	4,445	2,906	443	122	10,751	191
20	11	9	11	2	4	63	258	5	19	8	703	1	—	—	1	1	4	—	10

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APPENDIX IV

Total Numbers of Accidents reported in 1939, 1954, 1955

ANALYSIS BY INDUSTRIES

Industry (1)	1939			1954			1955		
	Non-Fatal	Fatal	Total	Non-Fatal	Fatal	Total	Non-Fatal	Fatal	Total
Textile									
COTTON	6,719	23	6,742	5,376	3	5,379	4,892	6	4,898
WOOL, WORSTED AND SHODDY ...	3,866	18	3,884	3,246	7	3,253	3,189	8	3,197
FLAX, HEMP AND JUTE	1,431	4	1,435	1,362	3	1,365	1,240	—	1,240
SILK, RAYON, etc.	712	3	715	797	1	798	746	—	746
HOSIERY	511	2	513	368	—	368	362	—	362
OTHER TEXTILES	823	4	827	617	1	618	575	—	575
(Textile Printing, Bleaching and Dyeing —Shown below)									
Total Textile	**14,062**	**54**	**14,116**	**11,766**	**15**	**11,781**	**11,004**	**14**	**11,018**
Non-textile									
CLAY, STONE, LIME AND CEMENT—									
Brick, pipe and tile making ...	2,712	17	2,729	2,076	7	2,083	2,128	9	2,137
Other clay, stone, lime and cement ...	2,008	13	2,021	1,944	15	1,959	1,881	17	1,898
Total	**4,720**	**30**	**4,750**	**4,020**	**22**	**4,042**	**4,009**	**26**	**4,035**
METALS—									
Metal extracting and refining ...	2,535	32	2,567	2,148	28	2,176	2,254	17	2,271
Metal conversion	3,634	26	3,660	4,509	20	4,529	4,610	26	4,636
Iron, Steel and other Metal rolling ...	12,504	40	12,544	7,856	28	7,884	7,724	18	7,742
Metal tube making and wire drawing	3,309	11	3,320	2,311	6	2,317	2,553	8	2,561
Metal founding	10,515	33	10,548	9,221	19	9,240	9,658	16	9,674
Metal galvanising, tinning, plating and enamelling	1,522	7	1,529	862	—	862	763	2	765
Total	**34,019**	**149**	**34,168**	**26,907**	**101**	**27,008**	**27,562**	**87**	**27,649**
ENGINEERING WORKS (OTHER THAN MACHINE MAKING), MACHINE AND OTHER TOOLS—									
Marine engine building and repairing	1,305	6	1,311	1,712	3	1,715	1,536	—	1,536
Locomotive building and repairing ...	2,459	7	2,466	2,163	3	2,166	1,927	4	1,931
Other engine building: transmission machinery	1,718	1	1,719	1,025	2	1,027	1,251	2	1,253
Boiler making	1,974	13	1,987	1,384	2	1,386	1,453	2	1,455
Constructional engineering ...	2,638	11	2,649	2,493	5	2,498	2,346	8	2,354
Electrical engineering	6,374	9	6,383	6,021	5	6,026	6,487	7	6,494
Hydraulic, ventilating and pneumatic engineering	904	3	907	878	1	879	902	1	903
Machine tool and other tool making	2,136	6	2,142	1,440	4	1,444	1,524	3	1,527
Total	**19,508**	**56**	**19,564**	**17,116**	**25**	**17,141**	**17,426**	**27**	**17,453**
MACHINERY, MACHINERY ACCESSORIES, ETC.—									
Textile machinery and accessories ...	985	2	987	959	2	961	956	2	958
Other miscellaneous machine making	2,488	6	2,494	2,964	4	2,968	3,227	8	3,235
General and jobbing engineering, making and repairing machinery	5,161	14	5,175	8,310	17	8,327	7,820	13	7,833
Railway & tramway plant & vehicles	3,752	13	3,765	4,106	6	4,112	3,700	4	3,704
Motor vehicles (other than steam) motor cycles, cycles, carts and carriages	7,812	35	7,847	8,401	14	8,415	8,869	16	8,885
Ordnance and munitions of war ...	5,014	17	5,031	2,872	5	2,877	2,977	5	2,982
Total	**25,212**	**87**	**25,299**	**27,612**	**48**	**27,660**	**27,549**	**48**	**27,597**
LIGHT METAL TRADES	5,606	10	5,616	3,897	7	3,904	4,285	5	4,290
INDUSTRIAL APPLIANCES (locks, bolts, screws, springs, chains, etc.) ...	2,433	3	2,436	1,684	2	1,686	1,784	3	1,787
MISCELLANEOUS METAL TRADES ...	2,517	12	2,529	2,348	8	2,356	2,375	9	2,384
SHIPBUILDING	9,342	84	9,426	8,408	61	8,469	8,403	46	8,449
AIRCRAFT	3,320	7	3,327	2,230	7	2,237	2,279	3	2,282
GENERAL WOODWORK—									
Sawmills, joinery and general woodworking	4,255	23	4,278	5,308	17	5,325	5,202	15	5,217
Box and packing case making ...	390	—	390	382	1	383	371	—	371
Brushes and other special woodware	513	2	515	370	—	370	344	—	344
Other builders' materials	875	3	878	676	3	679	747	1	748
Total	**6,033**	**28**	**6,061**	**6,736**	**21**	**6,757**	**6,664**	**16**	**6,680**
FURNITURE, ETC.—									
Cabinet and chair making, upholstery	1,154	3	1,157	795	—	795	744	—	744
Other furniture making	1,217	8	1,225	1,130	2	1,132	1,276	3	1,279
Total	**2,371**	**11**	**2,382**	**1,925**	**2**	**1,927**	**2,020**	**3**	**2,023**

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APPENDIX IV—*continued*

Total Numbers of Accidents reported in 1939, 1954, 1955

ANALYSIS BY INDUSTRIES

Industry (1)	1939			1954			1955		
	Non-Fatal	Fatal	Total	Non-Fatal	Fatal	Total	Non-Fatal	Fatal	Total
Non-textile—*continued*									
Pottery	1,059	4	1,063	1,145	1	1,146	1,108	3	1,111
Glass	1,545	6	1,551	1,818	2	1,820	2,095	1	2,096
Chemicals, etc.—									
Artificial manure	368	5	373	299	2	301	252	1	253
Coal tar	919	8	927	1,357	9	1,366	1,414	6	1,420
Other chemicals	2,512	17	2,529	4,407	23	4,430	4,437	33	4,470
Paint, colours and varnish ...	337	7	344	555	1	556	563	1	564
Total	4,136	37	4,173	6,618	35	6,653	6,666	41	6,707
Tanning, Currying Leather ...	1,114	4	1,118	780	1	781	826	5	831
Printing, Bleaching, Dyeing and Cleaning—									
Textile printing, bleaching and dyeing	1,426	10	1,436	1,136	—	1,136	1,054	4	1,058
Cloth finishing, raising, lapping, making up and packing ...	118	—	118	213	—	213	177	—	177
Job dyeing, other finishing, cleaning and dyeing	203	4	207	164	—	164	160	2	162
Laundries	770	4	774	669	2	671	675	—	675
Total	2,517	18	2,535	2,182	2	2,184	2,066	6	2,072
Wearing Apparel and Articles for Personal Use—									
Tailoring	1,201	—	1,201	543	—	543	491	1	492
Dress, millinery, underclothing and other wearing apparel	1,171	1	1,172	932	—	932	998	3	1,001
Boots, shoes, slippers and clogs ...	1,480	—	1,480	864	1	865	818	—	818
Total	3,852	1	3,853	2,339	1	2,340	2,307	4	2,311
Rubber Trades	1,677	5	1,682	1,936	3	1,939	2,124	6	2,130
Paper, Printing and Stationery—									
Paper, cardboard & millboard making	2,837	18	2,855	3,497	12	3,509	3,639	11	3,650
Letterpress and lithographic printing and bookbinding	1,670	1	1,671	1,627	2	1,629	1 841	—	1,841
Cardboard and paper box making ...	486	—	486	723	1	724	756	3	759
Other printing, photography, etc. ...	635	3	638	452	—	452	655	1	656
Total	5,628	22	5,650	6,299	15	6,314	6,891	15	6,906
Food—									
Flour and other milling	822	10	832	876	7	883	817	1	818
Bakeries	1,743	7	1,750	2,018	2	2,020	2,203	2	2,205
Confectionery (sugar), groceries, etc.	1,857	2	1,859	2,353	5	2,358	2,132	—	2,132
Other foods	3,941	12	3,953	4,675	9	4,684	4,727	5	4,732
Total	8,363	31	8,394	9,922	23	9,945	9,879	8	9,887
Drink—									
Alcoholic	2,898	16	2,914	2,308	1	2,309	2,423	9	2,432
Non-alcoholic	338	2	340	421	—	421	436	—	436
Total	3,236	18	3,254	2,729	1	2,730	2,859	9	2,868
Tobacco and Matches	538	—	538	494	—	494	505	—	505
Oil Cake, Oil Refining & Extracting	1,348	9	1,357	1,284	8	1,292	1,533	10	1,543
Soap, Starch, Candles, etc. ...	670	5	675	460	2	462	454	—	454
Fine Instruments, Jewellery, Sports Articles, etc.	1,331	2	1,333	1,505	2	1,507	1,463	—	1,463
Gas Works	1,955	15	1,970	3,419	17	3,436	3,283	14	3,297
Electrical Stations	1,174	15	1,189	2,508	19	2,527	2,534	18	2,552
Other Miscellaneous Industries ...	543	1	544	917	3	920	951	1	952
Total Non-Textile	155,767	670	156,437	149,238	439	149,677	151,900	414	152,314
Places under Ss. 105-108 of the Factories Act, 1937									
Docks, Sec. 105	6,209	69	6,278	6,536	32	6,568	7,246	48	7,294
Building Operations Sec. 107 { Construction ...	10,967	181	11,148	11,150	119	11,269	11,589	128	11,717
{ Maintenance ...	723	55	778	2,271	39	2,310	2,361	47	2,408
{ Demolition	258	25	283	310	14	324	427	9	436
Works of Engineering Construction, Sec. 108	3,580	42	3,622	2,130	42	2,172	1,973	39	2,012
Warehouses, Sec. 105	805	8	813	1,058	8	1,066	1200	4	1,204
Total places under Ss. 105-108 of the Factories Act, 1937	22,542	380	22,922	23,455	254	23,709	24,796	275	25,071
Grand Total	192,371	1,104	193,475	184,459	708	185,167	187,700	703	188,403

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APPENDIX V

Total Numbers of Accidents reported in 1939, 1954, 1955

ANALYSIS BY CAUSATION

Causation	1939			1954			1955		
	Fatal	Non-Fatal	Total	Fatal	Non-Fatal	Total	Fatal	Non-Fatal	Total
Machinery Moved by Mechanical Power									
PRIME MOVERS (Steam, Gas and other Engines, Electric Motors (not electric shock))	3	164	167	2	321	323	1	352	353
TRANSMISSION MACHINERY									
Shafting	13	117	130	9	75	84	5	47	52
Belts, Ropes, Pulleys, etc.	10	959	969	5	566	571	2	542	544
LIFTING MACHINERY	123	3,500	3,623	80	4,578	4,658	56	4,854	4,910
MACHINE TOOLS FOR METAL WORKING									
Milling Machines	—	623	623	—	335	335	1	351	352
Power Presses (other than punches)	—	556	556	1	490	491	1	501	502
WOODWORKING MACHINERY									
Circular Saws (all types)	4	1,543	1,547	4	1,596	1,600	3	1,561	1,564
Planing Machines (as defined in Regulations)	—	651	651	1	919	920	—	913	913
Vertical Spindle Moulding Machines	1	294	295	1	312	313	—	297	297
Other	—	749	749	—	642	642	1	654	655
ROLLERS OF CALENDERS, MIXERS, ETC. (NOT FOR METAL OR WOODWORKING)									
("NIP" ACCIDENTS)	2	644	646	—	782	782	1	806	807
OTHER	83	24,431	24,514	39	17,673	17,712	40	17,283	17,323
Transport (whether moved by power or not)									
RAILWAYS (Locomotives and Rolling Stock)	52	1,704	1,756	41	3,159	3,200	33	2,979	3,012
OTHER VEHICLES (excluding Hand Trucks, Bogies, etc.)	29	1,727	1,756	44	7,963	8,007	58	8,639	8,697
Other									
ELECTRICITY	29	558	587	33	674	707	42	697	739
EXPLOSIONS (including Boiler Back-draughts)	37	1,113	1,150	27	1,082	1,109	49	1,156	1,205
FIRES (not Dangerous Occurrences or Explosions)	16	407	423	15	410	425	20	505	525
GASSING	11	173	184	21	216	237	11	244	255
MOLTEN METAL, OTHER HOT OR CORROSIVE SUBSTANCES	26	8,307	8,333	9	6,666	6,675	9	6,617	6,626
Machinery not moved by Mechanical Power									
LIFTING MACHINERY	17	1,015	1,032	9	1,071	1,080	11	1,070	1,081
OTHER	—	2,583	2,583	1	2,260	2,261	2	2,372	2,374
Use of Hand Tools	11	18,267	18,278	7	15,119	15,126	4	14,954	14,958
Struck by Falling Body	107	21,561	21,668	75	16,634	16,709	63	16,647	16,710
Persons Falling	435	24,923	25,358	255	28,137	28,392	258	28,604	28,862
Stepping on or Striking Against Objects (not included in other Cols.)	24	14,419	14,443	4	15,034	15,038	5	15,718	15,723
Handling Goods or Articles in manufacturing or carrying processes (not included in other Cols.)	39	48,996	49,035	10	48,289	48,299	19	49,904	49,923
Other	32	12,387	12,419	15	9,456	9,471	8	9,433	9,441
Total All Accidents	1,104	—	193,475	708	—	185,167	703	—	188,403
Total Non-Fatal Accidents	—	192,371	—	—	184,459	—	—	187,700	—
Additional Accident Particulars									
CLEANING OF MACHINERY IN MOTION (included elsewhere in Table)									
Men	—	491	491	3	593	596	1	561	562
Women and Young Persons	1	678	679	1	414	415	—	458	458
EYE INJURIES FROM PARTICLES OR FRAGMENTS thrown off in course of process (included elsewhere in Table)	1	4,753	4,754	—	4,551	4,551	—	4,445	4,445
EYE INJURIES—other (included elsewhere in Table)	—	3,751	3,751	1	2,912	2,913	1	2,906	2,907
MATERIALS OR ARTICLES while in motion in a machine (included elsewhere in Table)	4	435	439	—	442	442	1	443	444
IMMERSION OF ANY PART OF THE BODY in fixed vessel, etc., containing scalding, corrosive or poisonous fluid (included elsewhere in Table)	11	136	147	4	151	155	4	122	126
SEPSIS (included elsewhere in Table)	36	21,492	21,528	1	11,456	11,457	—	10,751	10,751
OTHER THAN ELECTRICAL BUT ASSOCIATED WITH ELECTRICITY (included elsewhere in Table)	—	—	—	9	186	195	10	191	201

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APPENDIX VI

Dangerous Occurrences, 1955

As notified to Inspectors in accordance with the Dangerous Occurrences (Notification) Regulations, 1947, made under Section 65 of the Factories Act, 1937, which relate to all cases of :

I. Bursting of a revolving vessel, wheel, grindstone or grinding wheel moved by mechanical power;

II. Collapse or failure of a crane, derrick, winch, hoist or other appliance used in raising or lowering persons or goods, or any part thereof (except the breakage of chain or rope slings), or the overturning of a crane;

III. Explosion or fire causing damage to the structure of any room or place in which persons are employed, or to any machine or plant contained therein, and resulting in the complete suspension of ordinary work in such room or place or stoppage of machinery or plant for not less than five hours, where such explosion or fire is due to (i) the ignition of dust, gas or vapour, or (ii) the ignition of celluloid or substances composed wholly or in part of celluloid;

IV. Electrical short circuit or failure of electrical machinery, plant, or apparatus attended by explosion or fire or causing structural damage thereto, and involving its stoppage or disuse for not less than five hours;

V. Explosion or fire affecting any room in which persons are employed and causing complete suspension of ordinary work therein for not less than twenty-four hours;

VI. Explosion of a receiver or container used for the storage at a pressure greater than atmospheric pressure of any gas or gases (including air) or any liquid or solid resulting from the compression of gas.

Industry	All Cases of					
(1)	I (2)	II (3)	III (4)	IV (5)	V (6)	VI (7)
Textile						
Cotton	1	4	2	1	10	1
Wool, Worsted and Shoddy	—	1	—	1	5	—
Flax, Hemp and Jute	—	—	—	—	—	—
Silk, Rayon, etc. ..	1	1	1	1	1	—
Hosiery	—	—	—	—	5	—
Other Textiles .. (Textile Printing, Bleaching and Dyeing—shown below)	—	—	1	—	5	—
Total Textile ..	2	6	4	3	26	1
Non-textile						
Clay, Stone, Lime and Cement—						
Brick, pipe and tile making ..	—	—	—	—	—	—
Other clay, stone, lime and cement	—	4	2	1	4	—
Total ..	—	4	2	1	4	—
Metals—						
Metal extracting and refining ..	—	4	1	—	2	1
Metal conversion	3	12	2	1	3	—
Iron, steel and other metal rolling ..	—	5	—	1	1	1
Metal tube making and wire drawing	2	3	—	1	3	—
Metal founding ..	14	9	5	2	4	—
Metal galvanising, tinning, plating and enamelling	—	—	2	3	2	—
Total ..	19	33	10	8	15	2

Industry	All Cases of					
(1)	I (2)	II (3)	III (4)	IV (5)	V (6)	VI (7)
Non-textile—*contd.*						
Engineering Works (other than Machine Making), Machine and other Tools—						
Marine engine building & repairing	—	—	—	—	—	—
Locomotive building & repairing	1	—	—	1	1	—
Other engine building: transmission machinery ..	9	—	—	—	1	1
Boiler making ..	—	1	1	—	—	—
Constructional engineering ..	1	3	—	—	—	—
Electrical engineering	8	7	4	9	5	1
Hydraulic, ventilating and pneumatic engineering ..	1	1	1	—	1	—
Machine tool and other tool making	5	—	1	—	2	—
Total ..	25	12	7	10	10	2
Machinery, Machinery Accessories, etc.—						
Textile machinery and accessories	2	—	1	—	1	—
Other miscellaneous machine making	8	1	1	1	2	—
General & jobbing engineering, making & repairing machinery ..	9	5	—	3	4	—
Railway & tramway plant & vehicles	6	1	—	—	2	1
Motor vehicles (otherthansteam), motor cycles, cycles, carts and carriages ..	6	13	3	3	17	2
Ordnance and munitions of war ..	4	3	—	1	2	—
Total ..	35	23	5	8	28	3

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APPENDIX VI—*continued*

Dangerous Occurrences, 1955—*continued*

Industry (1)	All Cases of I (2)	II (3)	III (4)	IV (5)	V (6)	VI (7)
Non-textile—*contd.*						
LIGHT METAL TRADES	2	1	8	—	13	2
INDUSTRIAL APPLIANCES (LOCKS, BOLTS, SCREWS, SPRINGS, CHAINS, ETC.)	2	1	—	1	2	—
MISCELLANEOUS METAL TRADES ..	5	4	1	2	5	1
SHIPBUILDING ..	1	3	1	—	—	1
AIRCRAFT	3	1	3	1	—	1
GENERAL WOODWORK—						
Sawmills, joinery & general woodworking ..	—	6	1	1	27	—
Box and packing case making ..	—	1	—	—	1	—
Brushes and other special woodware	—	—	1	—	3	—
Other builders' materials ..	—	—	1	—	1	—
Total ..	—	7	3	1	32	—
FURNITURE, ETC.—						
Cabinet and chair making, upholstery	—	—	1	2	16	—
Other furniture making ..	—	—	1	1	9	—
Total ..	—	—	2	3	25	—
POTTERY	—	1	—	—	2	—
GLASS	—	—	2	—	1	—
CHEMICALS, ETC.—						
Artificial manure	—	—	—	—	—	—
Coal Tar ..	1	2	6	—	1	1
Other chemicals ..	4	26	19	10	10	2
Paint, colours and varnish ..	—	1	2	—	4	—
Total ..	5	29	27	10	15	3
TANNING, CURRYING LEATHER ..	—	—	—	—	3	—
PRINTING, BLEACHING, DYEING & CLEANING—						
Textile printing, bleaching and dyeing	—	—	1	—	3	—
Cloth finishing, raising, lapping, making-up and packing	—	—	—	—	1	—
Job dyeing, other finishing, cleaning and dyeing	—	—	—	1	2	—
Laundries ..	—	—	2	—	3	—
Total ..	—	—	3	1	9	—

Industry (1)	All Cases of I (2)	II (3)	III (4)	IV (5)	V (6)	VI (7)
Non-textile—*contd.*						
WEARING APPAREL AND ARTICLES FOR PERSONAL USE—						
Tailoring ..	—	—	—	1	4	—
Dress, millinery, underclothing & other wearing apparel ..	—	1	—	—	8	—
Boots, shoes, slippers and clogs ..	—	—	—	—	1	—
Total ..	—	1	—	1	13	—
RUBBER TRADES ..	4	1	4	—	5	1
PAPER, PRINTING AND STATIONERY—						
Paper, cardboard and millboard making ..	2	6	—	—	9	—
Letterpress and lithographic printing and bookbinding ..	—	—	1	—	6	—
Cardboard and paper box making	—	1	—	1	1	—
Other printing, photography, etc.	—	1	3	1	1	—
Total ..	2	8	4	2	17	—
FOOD—						
Flour and other milling ..	—	—	—	1	4	—
Bakeries ..	—	—	8	1	10	1
Confectionery (sugar), groceries, etc.	—	1	—	—	1	—
Other foods ..	—	1	3	—	1	1
Total ..	—	2	11	2	16	2
DRINK—						
Alcoholic ..	—	1	1	1	7	—
Non-alcoholic ..	—	—	1	—	—	—
Total ..	—	1	2	1	7	—
TOBACCO & MATCHES	—	1	—	2	—	—
OILCAKE, OIL REFINING & EXTRACTING	1	1	1	1	2	—
SOAP, STARCH, CANDLES, ETC. ..	1	—	1	—	3	—
FINE INSTRUMENTS, JEWELLERY, SPORTS ARTICLES, ETC. ..	1	—	3	1	5	—
GAS WORKS	2	11	4	—	—	—
ELECTRICAL STATIONS	—	7	8	83	1	—
OTHER MISCELLANEOUS INDUSTRIES	—	—	1	—	2	—
Total Non-Textile ..	108	152	113	139	235	18
Places under Ss. 105-108 of the Factories Act, 1937: Total ..	—	95	1	2	3	2
Docks, Sec. 105 ..	—	52	—	—	1	—
BUILDING OPERATIONS, SEC. 107 — Construction	—	29	—	—	—	2
BUILDING OPERATIONS, SEC. 107 — Maintenance	—	2	1	—	—	—
BUILDING OPERATIONS, SEC. 107 — Demolition	—	—	—	—	—	—
WORKS OF ENGINEERING CONSTRUCTION, SEC. 108 ..	—	8	—	1	—	—
WAREHOUSES, SEC. 105	—	4	—	1	2	—
Grand Total ..	110	253	118	144	264	21

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APPENDIX VII—Prosecutions, 1955

Offence, Number, Result

Column 2 shows the number of firms or persons against whom prosecution was approved during 1955, for each of the main classifications of offence. The same firm or person may therefore be included in some cases in the figures relating to more than one classification.

In Column 5 the figures include informations withdrawn on conviction on alternative charges.

Type of Offence (1)	Number of Persons or Firms Prosecuted (2)	Number of Informations (3)	Result: Convictions (4)	Result: Withdrawn (5)	Result: Dismissed (6)	Result: Dealt with under Section 7, Criminal Justice Act, 1948 (7)	Fines Imposed (Gross) (8)	Costs Ordered Against Defendant (9)
							£ s. d.	£ s. d.
I. FORMS	75	106	95	9	1	1	322 8 0	11 9 0
II. HEALTH	96	151	147	1	—	3	449 0 0	20 2 8
(a) CLEANLINESS								
General	16	17	17	—	—	—	58 0 0	5 7 0
Special requirements ..	1	1	1	—	—	—	2 0 0	2 0
(b) REMOVAL OF DUST OR FUMES								
Causing death or injury	—	—	—	—	—	—	—	—
Other	6	6	6	—	—	—	20 4 0	—
(c) MEDICAL EXAMINATIONS								
Fitness of Young Persons	63	114	110	1	—	3	270 6 0	11 10 8
Periodical Examinations							10 0 0	—
in dangerous trades ..	1	1	1	—	—	—	88 10 0	3 3 0
(d) OTHER	9	12	12	—	—	—		
III. SAFETY	729	866	764	73	27	2	9,273 18 0	539 10 3
(a) FENCING AND CONSTRUCTION OF MACHINERY								
Causing death or injury	295	296	287	1	8	—	4,904 4 0	187 11 4
Other	132	168	124	44	—	—	849 8 0	44 5 4
(b) USE OF LIFTING MACHINERY	29	29	27	—	2	—	547 0 0	30 17 6
Causing death or injury	41	55	45	6	2	2	307 0 0	21 16 7
Other								
(c) PRECAUTIONS AGAINST FALLS FROM HEIGHTS	43	43	38	1	4	—	767 0 0	80 2 8
Causing death or injury	94	160	146	9	5	—	813 4 0	88 6 7
Other								
(d) OTHER (INCLUDING USE OF ELECTRICITY)	32	33	32	—	1	—	793 16 0	54 3 4
Causing death or injury	63	82	65	12	5	—	292 6 0	32 6 11
Other								
IV. WELFARE	31	35	35	—	—	—	110 13 0	2 7 0
(a) WASHING AND BATH ACCOMMODATION ..	7	7	7	—	—	—	16 4 0	17 6
(b) FIRST AID EQUIPMENT	14	14	14	—	—	—	40 5 0	2 6
(c) OTHER	10	14	14	—	—	—	54 4 0	1 7 0

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APPENDIX VII—Prosecutions, 1955—*continued*

Offence, Number, Result

Type of Offence (1)	Number of Persons or Firms Prosecuted (2)	Number of Informations (3)	Result: Convictions (4)	Result: Withdrawn (5)	Result: Dismissed (6)	Result: Dealt with under Section 7, Criminal Justice Act, 1948	Fines Imposed (Gross) (8)	Costs Ordered Against Defendant (9)
							£ s. d.	£ s. d.
V. EMPLOYMENT ..	58	200	193	6	1	—	362 0 0	27 18 6
(a) BEFORE OR AFTER LEGAL HOURS	24	83	78	5	—	—	161 10 0	6 15 0
(b) AT NIGHT	5	5	5	—	—	—	11 0 0	4 19 0
(c) ON SUNDAY OR HOLIDAY	26	106	106	—	—	—	188 10 0	16 3 6
(d) OTHER	3	6	4	1	1	—	1 0 0	—
VI. OTHER	1	2	—	1	1	—	—	8 0
VII. TRUCK	—	—	—	—	—	—	—	—
TOTALS	990	1,360	1,234*	90†	30	6	10,517 19 0	601 15 6

* Includes 7 Admonitions. † Includes 77 cases withdrawn on "Alternative Charge."

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APPENDIX VIII

Administration of the Factories Acts (1945-1955)

Subject (1)	1945 (2)	1950 (3)	1955 (4)
Authorized Staff (Inspectors) excluding Factory Canteen Advisers	403	380	381
*Expenditure**	£368,430	£466,832	£752,898
Factories, etc.:—			
1. Factories (with power)	180,944	211,166	213,833
2. ,, (without power)	44,162	29,898	17,644
3. Docks, etc.	2,927	2,797	2,625
4. Warehouses	5,777	5,578	5,647
5. Buildings (i) Sites	3,609†	20,673	26,821
(ii) Contractors	—	—	36,266
6. Works of Engineering Construction (i) Sites	622†	1,139	1,659
(ii) Contractors	—	—	1,792
7. Premises under S.154, Factories Act, 1937	995	962	759
8. Firms registered under Lead Paint Act, 1926	28,261	29,271	24,680
9. Textile Works under Particulars Section:—			
(i) Factories (with power)	6,087	6,498	6,676
(ii) ,, (without power)	565	551	450
Visits to:—			
(*a*) Factories (with power)	249,739	223,785	220,238
(*b*) ,, (without power)	26,291	15,595	6,801
(*c*) Building Operations (Contractors) ..	—	22,370	35,939
(*d*) Works of Engineering Construction (Contractors)	—	1,065	1,462
(*e*) Other places under Acts	12,063	8,754	9,539
(*f*) Number of above visits before or after legal hours	6,719	13,113	12,390
Other official visits and attendances	45,337	43,755	42,210
Prosecutions (Number of Informations)	1,255	877	1,360
Cases of Notifiable Industrial Poisoning or Disease	412	491	577
Reported Accidents:—			
1. Fatal	851	799	703
2. Non-fatal‡	239,802	192,260	187,700
Dangerous Occurrences	680	776	910
Appointed Factory Doctors	1,864	2,067	2,144
Medical Examinations for employment of Young Persons§:—			
1. First examination for employment under the Factories Acts	230,045**	382,144**	266,321
2. Subsequent examinations	—	—	235,885
3. For employment of boys over 16 at night ...	5,048	6,247	7,414
4. Under Regulations, etc.	344,958	330,675	424,216

* Relates to financial year commencing 1st April.

** Includes first and subsequent examinations.

† The figures for 1945 relate to the number of sites remaining on the Register at 31st December: the figures for subsequent years relate to the number registered at any time during the year.

‡ On basis of three days' incapacitation.

§ As from 1st October, 1948, the provisions of the Factories Act, 1948 (a) extended the system of medical examination to all young persons entering factory employment, (b) extended the application of the system to some other classes of employment under the Act; and (c) required the re-examination of all young persons at least once a year.

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Asbestosis and Cancer of the Lung

In the Report for 1954, analyses were made by age and duration of exposure of 205 male and 139 female deaths during the years 1924 to 1954 inclusive, which were either caused by asbestosis or in which asbestosis had been proved at autopsy.

During 1955 a further 21 such cases came to light. Cancer of the lung was present in 10 of the 17 male cases and in 3 of the 4 female cases. In one case was tuberculosis recorded in addition to asbestosis.

The additional cases do not as yet justify a repetition of the full analyses by age and duration of exposure carried out last year, but Table 30 below shows the number and percentage of the 365 cases to the end of 1955 in which asbestosis alone, or asbestosis with tuberculosis, or with cancer of the lung was present.

TABLE 30

ASBESTOSIS: DEATHS RECORDED FROM MARCH, 1924—DECEMBER, 1955

Diagnosis	Male		Female		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Asbestosis	127	57·2	85	59·4	212	58·1
Asbestosis and Pulmonary Tuberculosis	47	21·2	41	28·7	88	24·1
Asbestosis and Cancer of the Lung	48	21·6	17	11·9	65	17·8
Total	222	100·0	143	100·0	365	100·0

Note: 4 male and 8 female cases also had cancer of sites other than the lung and are included under "Asbestosis".

The proportion of all cases with cancer of the lung was 17·8 per cent compared with 13·2 per cent and 16·0 per cent in the cases which had come to light by 1947 and 1954 respectively. This proportion for males and females was 21·6 per cent and 11·9 per cent compared with 20·0 per cent and 10·1 per cent in the 1954 analysis.

Death from Beryllium Granulomatosis and Silicosis

A fatal case of beryllium granulomatosis and silicosis came to light during the year in a man, aged 41, who for five years before his death had been in receipt of a 100 per cent pneumoconiosis disability pension. He had been engaged at intervals for at least six years in the grinding of silica gel under dusty conditions and for four years had worked in a room where fluorescent lamp powder containing beryllium was manufactured. Post-mortem examination showed that in addition to terminal congestion and pneumonia there were nodules characterized by large mononuclear cells, lymphocytes and occasional giant cells. Within these nodules there were crystals having the general characteristics of cristobalite, and near the nodules there were purple staining amorphous deposits. Similar structures appeared in the hilar lymph glands. There were also small but definite whorled silicotic nodules. Analysis of the lung ash showed 0·22 per cent of silicon dioxide of the dry weight of the lung but no beryllium. In general, the picture was a combination of beryllium granulomatosis and silicosis.

...ers of Luminisers, X-ray, Radium and Radioisotope Workers and ...kers Exposed to Industrial Solvents, etc.

...minisers

Examinations were carried out on 136 luminisers (112 female and 24 male) ...9 cleaners at thirty-four factories during the year. On the whole, the ...al health of these workers was satisfactory and any abnormalities found ...e blood picture were relatively slight in character. Immature cells, usually ...the nature of primitive monocytes but in some cases Türck cells, were ...sent in 14 cases (10·3 per cent). This was thought to be due to hyper-...ulation of the reticulo-endothelial system, especially in the early stages of ...minising, and was quite evident in one case. Blood examination on this ...man at a pre-employment examination three weeks before she began ...minising was normal in all respects but after employment for only five days ...examination showed that her stained film contained several primitive cells ...the monocytic type.

No skin lesions definitely attributable to beta radiation were observed, ...four girls had red patches on the fingers which, although they may have ...en domestic in origin, are being kept under observation.

In the luminising rooms of two factories considerable contamination of ...ors, benches and overalls was found, while the contamination of waste ...kets, owing to infrequent emptying and inadequate cleaning, was also ...ted.

Most firms were careful to see that the luminisers wore the National Physical Laboratory films at least as fully as required by the Regulations. The dosages shown were in most cases well below the level of 0·3R per week but the reports on four factories stated that some of the films were spotted, indicating contamination by radio-active dust.

In three instances the dosages were higher than the tolerance level. In one of these, a dosage of 0·6R gamma and 1·2R beta radiation was due to failure to wear the rubber apron provided, the overalls worn showing contamination even after laundering. In another case, a supervisor with thirty years' experience, a dosage of 0·5R gamma and 1·6R beta radiation was due to her habit of mixing the luminous compound without taking sufficient precautions to avoid contamination. A dosage of 0·1R gamma and 0·8R beta in the third case was thought to be due to the large number of luminised instruments habitually left on the benches.

X-Ray Workers

Eight firms were visited and 63 male and 9 female operatives examined during the year. Six of these firms were engaged in the production and testing of X-ray equipment, while the remaining two firms were using X-rays for testing foods and metals respectively. The number of cases in which slight abnormalities were found was leucocytosis 2, relative lymphocytosis without neutropenia 9, slight anaemia 3, absolute lymphocytosis with neutropenia 1, and slight leucopenia 1.

Radium Workers

Two firms using radium for purposes other than luminising or radiography were visited. In one firm engaged on the manufacture of luminous compound, 8 men and 2 women were examined, none of whom showed any abnormalities of the blood picture. In the other firm, where radium foil was used, 2 men and 2 women were examined, all of whom were in good health, but one woman was slightly anaemic and the other had a slight relative lymphocytosis.

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