U. S. DEPARTMENT OF LABOR
JAMES J. DAVIS, Secretary
BUREAU OF LABOR STATISTICS
ETHELBERT STEWART, Commissioner

BULLETIN OF THE UNITED STATES BUREAU OF LABOR STATISTICS . . . . No. 298
INDUSTRIAL ACCIDENTS AND HYGIENE SERIES

CAUSES AND PREVENTION OF ACCIDENTS IN THE IRON AND STEEL INDUSTRY, 1910-1919

By LUCIAN W. CHANEY

JUNE, 1922

WASHINGTON
GOVERNMENT PRINTING OFFICE
1922

CONTENTS.

CHARTS.

ILLUSTRATIONS.

BULLETIN OF THE

U. S. BUREAU OF LABOR STATISTICS.

NO. 298. WASHINGTON. JUNE, 1922

CAUSES AND PREVENTION OF ACCIDENTS IN THE IRON AND STEEL INDUSTRY, 1910-1919.

CHAPTER I.—INTRODUCTION AND SUMMARY.

This report endeavors to bring together the results of a study of accidents in the iron and steel industry which has been going on in the Bureau of Labor Statistics during the last 10 years.

Preliminary to the investigation undertaken in 1910 a survey was made of conditions in England, France, and Germany. Following this, accident data were gathered covering, with a fair degree of completeness, a 12-month period ending in 1910. An effort was made to include the preceding year, but the material did not prove to be such that it could be satisfactorily used. Fortunately some of the larger companies had preserved records going back to 1907 and in a few cases to still earlier years. By means of these it was possible to get a fair idea of conditions that prevailed at this earlier period. The results of that investigation were published in 1913.[1] While the report was still in preparation the bureau began systematically to accumulate data from year to year. As soon as such data were assembled for a five-year period a critical study of the facts was was undertaken. The difficulties attending an adventure into untried fields delayed its completion until 1918, when a second report was published.[2] This included a review of a portion of the industry (about 50 per cent) extending from 1910 to 1917. The detailed study was confined to the five years 1910 to 1914. In these years the number of workers varied from 202,157 to 319,919, the total for the 5 years being 1,310,919. The total number of accidents considered was 232,909. For the earlier years (1907 to 1909) the records of six plants were available. The number of their workers varied from 19,481 to 29,766. This group carries the study back to a point antedating the beginning of the organized safety movement.

PREPARATION AND USE OF RATES.[3]

A proper base.—While through usage the "full-year or 300-day worker" had become the recognized standard in the preparation of

[1] Conditions of Employment in the Iron and Steel Industry, Vol. IV, Accidents and Accident Prevention, S. Doc. No. 110, 62d Cong., 1st sess., 1913.

[2] The Safety Movement in the Iron and Steel Industry, 1907 to 1917, Bulletin No. 234 of the United States Bureau of Labor Statistics.

[3] See Chap. II.

accident rates,[4] after careful consideration of the whole subject, the committee on statistics and compensation insurance cost of the International Association of Industrial Accident Boards and Commissions reached the conclusion that the most satisfactory base would be the number of hours of exposure, sometimes designated "man hours." For example, a factory having an average employment of 1,000 and being in operation 2,750 hours during a year would have 2,750,000 hours of exposure or "man hours."

The recommendation of the committee, which is followed in the present report, is that rates be expressed in relation to hours of exposure in units of 1,000 hours and decimal multiples thereof. For example, frequency of accident rates will be the number of cases per 1,000,000 hours of exposure.

Industrial rates.—It is possible and desirable to use this standard of measurement not only in the consideration of accidents but also in the study of many other phases of industrial life, such as, for example, the various phases of "labor turnover."

Accident rates.—In all of its recent studies the Bureau of Labor Statistics has used two forms of rates—accident frequency rates and accident severity rates. Accident frequency rates, which show the number of cases per 1,000,000 hours' exposure, are fairly satisfactory when applied to the same establishment from year to year or when applied to works in which closely similar conditions prevail. They fail entirely when it is desired to get an idea regarding the comparative hazard of dissimilar departments and industries. To meet this difficulty the bureau worked out early in 1914 a system of time equivalents for the different sorts of injury, expressed in terms of days lost. This system, in modified forms, has since been in use in the various publications of the bureau. The system now followed is that which the committee on statistics of the International Association of Industrial Accident Boards and Commissions finally evolved. In that system the fundamental equivalent is one of 6,000 days for death. Other equivalents adjusted to this are applied to permanent disabilities, such as loss of arm (4,000 days). The sum of such equivalents is then divided by the customary base, the hours of exposure, the resulting ratio per 1,000 hours' exposure being the accident severity rate.

The need for such a rate may be strikingly illustrated by comparing the iron and steel industry with machine building. In one annual period machine building had a frequency of 39.3 cases per 1,000,000 hours' exposure. In a year showing similar conditions an iron and steel plant had a frequency of 38.1. Even a casual acquaintance with the two would be convincing that this apparently greater hazard in machine building could not be in accordance with the facts. The conditions of the iron and steel industry are certainly more dangerous than those of the machine shop. A comparison of severity rates is enlightening on this point. Machine building shows 1.8 days lost per 1,000 hours' exposure, while the steel plant has 7.0 days. It is evident that the severity rate is greatly superior to the frequency rate in measuring relative hazard.

The severity rate is applicable with equal or greater appropriateness to the study of causes, location, and nature of injury and similar subjects, and is so used in this report.

---

[4] For the methods of determining this base, see p. 18.

PHYSICAL CAUSES OF ACCIDENT—THE DEPARTMENTS COMPARED.

Each of the chief groups of accident causes, such as machinery, falls, etc., is presented in Chapter III in such a way as to show as clearly as possible the relative conditions in the various departments. This is accomplished by presenting first a detailed showing of the smaller groups into which each general cause group is divided and then a summary table and chart. The method pursued may be illustrated by the following specific cases:

Machinery.[5]—Considering machinery as a cause of accidents it is found that the electrical department stands at the head of the departments in which there were injuries from this cause, with a rate of 31.38 days per 10,000 hours' exposure, following which are open hearths (19.25 days); fabricating (18.55 days); Bessemer (16.74 days), and blast furnaces (14.52 days). It should be noted that the inclusion of cranes and hoists under the heading "machinery" materially increases the rates, showing that under a correct classification power-driven machinery is the most serious of hazards.

Part of machine.[6]—Of the parts of machines classified as causing accidents the "point of operation" is responsible on the whole for the greatest severity of injury; for example, it causes higher rates than any other part of the machinery in the following departments: Fabrication (5.04 days), sheet rolling mills (2.81 days), and the mechanical department (2.23 days).

Operation or condition.[7]—In accord with the above it appears that the operation of machines contributes most largely to severity in a majority of the departments. Some of the departments showing the higher rates for operation of machines are: Fabricating (3.71 days); blast furnaces (3.00 days); tube mills (3.04 days); and mechanical departments (2.43 days).

Vehicles.[8]—In connection with vehicles as a cause of accidents, yard employees suffer most seriously, their accident severity rate from this cause being 54.35 days per 10,000 hours' exposure; in fact, no other single cause of injury shows so high a rate. Other characteristic departments of the iron and steel industry showing high severity rates from this cause are as follows: Blast furnaces (18.96 days); Bessemer (13.50 days); open hearths (11.77 days); heavy rolling mills (5.92 days).

Hot substances.[9]—Regarding injuries due to heat the highest severity rate (24.98 days) occurred in the electrical department. While this was the case in this five-year period (1915 to 1919) it is possible that this is exceptional. Other characteristic departments are in the following order as regards severity of injury caused by hot substances: Bessemer (24.03 days); blast furnaces (18.54 days); open hearths (16.65 days).

Falls of worker.[10]—In this cause group the electrical workers again head the list (11.21 days). This is due largely to the hazards of the linemen, who must often work at an elevation and exposed to electric shocks which may cause falls. The blast furnace (7.41 days) evidently has a considerable number of falling hazards likely to result in severe injury.

---

[5] See Table 4.
[6] See Table 5.
[7] See Table 6.
[8] See Table 8.
[9] See Table 10.
[10] See Table 12.

Falling objects.[11]—The greatest severity (8.61 days) in this cause group is found in the Bessemer department, followed by open hearths (8.06 days), foundries (5.80 days), and blast furnaces (5.50 days).

Handling objects and tools.[12]—This cause group is notable for high frequency and relatively low severity. Sheet rolling mills, which in all other cause groups is well down the list in severity, is here at the top (5.49 days). This is due to a large number of more or less severe cuts and lacerations of the hands arising in connection with opening and handling the packs of sheets. The mechanical department, next in order (5.25 days), is the typical tool-using department and a considerable portion of its rate arises in connection with such use. That even here, where carefulness on the part of the workers is a most important factor, there are possibilities of improvement in an engineering way is illustrated by the experience of one company, which had numerous accidents due to nails flying from hammers in their shipping department. After introducing hammers with corrugated faces such accidents were materially reduced.

Miscellaneous causes.—In this group blast furnaces (14.03 days) have the serious hazard. This is due to the exposure to asphyxiating gas, which continues to claim a number of victims each year.

PHYSICAL CAUSES OF ACCIDENT—THE DEPARTMENTS ANALYZED.[13]

As it is impossible to make a summary of the chapter on this subject, only some of the conspicuous points are here touched upon.

In order to determine the importance of the influences which act upon accident causes it is necessary to follow the course of the rates from year to year and also to know somewhat intimately the history of the changes in equipment and method which have occurred during the same period.

BLAST FURNACES.[14]

In blast furnaces the characteristic accident cause groups are subdivisions of the general group of "hot substances." They are "break-outs," "explosions" connected with slips, and "gas flames." Each of these has its appropriate remedy in some form of structural improvement. Asphyxiating gas is also a serious menace in the blast furnace and must be controlled, if at all, by better construction.

The course of accidents from year to year will be shown to better advantage at a later point where the experience of the departments is detailed more fully. In this connection it is sufficient to call attention to the fact that the fairly steady decline which appears in the rates is not confined to any particular group of causes. Some causes are naturally much more sensitive to fluctuating industrial conditions than others, but all of them have been influenced by the efforts at prevention which have been in progress during the period.

Much light is shed upon the proper point for applying effort at accident control by considering the relation of special occupations to the causes. For example, it appears that injury from hot substances is much more common among the members of the cast-house crew than among other blast-furnace workers, while asphyxia is distributed

[11] See Table 14.
[12] See Table 15.
[13] See Chap. IV.
[14] See pp. 51 to 66.

almost uniformly. Such facts indicate quite definitely the limitations and particular direction of special effort.

STEEL WORKS AND FOUNDRIES.[a]

Steel works and foundries present in a modified form the hazard of "hot substances." The effective control is along lines similar to those suggested for blast furnaces.

Open hearths.—Among the occupations of open hearths common labor has much the highest frequency rate. In injuries due to "hot substances," for example, the rate is 30.1 cases against 14.0 cases for pouring-platform workers, who stand next. In fact, common labor has the highest rate in each cause group except "handling tools and objects" in which, naturally, the class of workers which includes the specially tool-handling mechanics is highest, with 8.3 cases, while common labor has 4.9 cases.

Bessemer steel works.—The Bessemer department has two items of procedure peculiar to itself which require some special efforts at control. When the blast is turned into the converter many molten particles are thrown out. Ordinarily these are not of a size to be particularly dangerous, but at times they may cause serious burns. Screens protecting the workers are now frequently used with good effect, but more important probably is the adoption of a plan of work which does not require the men to expose themselves as much as formerly. The second item is the throwing of heavy masses of scrap into the converters. When this was done directly the men were exposed to great heat and often the masses of scrap would fall to the pit floor, seriously endangering anyone working there. In the best plants this is now done behind water-cooled screens and through chutes which make a fall to the floor below nearly impossible.

ROLLING MILLS.[15]

In heavy rolling mills the element of hazard which appears to be most difficult to control is "hot substances." In all other particulars there is marked improvement. This control has been due largely to the introduction of improved machinery, both in the apparatus used directly in the rolling process and in such accessory apparatus as cranes.

In tube mills there is a combination of mill processes with machine-shop conditions, making the problem of control quite different. These mills have scored a remarkable success in the reduction of accident frequency, while the severity rate, fairly low at the beginning, has undergone relatively much less change.

The sheet mills present the unusual condition of a rising frequency rate while the severity rate is falling. This was found, on analysis, to be due to the group of employees particularly characteristic of this department. When all sheet-mill workers are taken as a unit they show declining rates. The "hot-mill crews," however, when isolated, have rising rates in both frequency and severity. It is probable that the rate being generally lower than in other departments and the rise not being very conspicuous, less attention has been given to conditions than they have deserved.

---

[a] See pp. 67 to 76.

[15] See pp. 76 to 83.

MECHANICAL, FABRICATING, AND YARD DEPARTMENTS.[16]

The control of accident causes in mechanical and fabricating operations must in the nature of the case be considerably a matter of personal care. So many of the operations are of a personal and manual character that the individual worker's attitude must be a material factor. Indeed, it has been found that whenever an effort which succeeds in interesting the men of such departments is undertaken the frequency of accident at once begins to decline in a remarkable manner.

Mechanics and fabricators are the typical machine users. It is therefore in these departments that the relative importance of working machines and other similar forms of hazard can be most readily determined. In no year covered by this study did the contribution of machines to the severity rate exceed 30 per cent. The average is about 10 per cent and it sometimes drops to 4 per cent. The working machine is therefore not a negligible source of injury, but is of relatively minor importance.

The yard department has its chief danger in the operation of power vehicles. In the plants studied the greater number of cases arise from coupling and uncoupling cars. The obvious remedy is the introduction of automatic couplers. The severity rate receives its greatest contribution from the men being run down by moving locomotives and cars. A study of these cases shows beyond question that improvement in such matters as grade crossings, clearances, permanent signal apparatus, and safety appliances on cars and locomotives is the main factor in an improved general condition.

RELATION OF ACCIDENT CAUSES TO LOCATION, NATURE, AND RESULTS OF INJURY.[17]

There has been attempted in this report a sort of study which has not hitherto been tried on any considerable scale. The number of cases arising from a given cause and affecting different portions of the body has been commonly presented, but no one has hitherto applied the method of severity rating to indicate the varying hazards which a workman encounters of being injured from the operation of certain causes which have their incidence upon definite parts of the body.

CAUSES AND LOCATION OF INJURY.[18]

In blast furnaces the cases which can not be classified either by specific cause or bodily locality have the highest severity rate (10.28 days). In the Bessemer department hot substances which affect the body in general have the highest rate (14.68 days). The same situation prevails in open hearths (10.81 days). Foundries have the greatest severity in cases due to machinery and affecting the thorax and pelvis (5.94 days). Machinery leads in heavy rolling mills, but no particular locality is notably affected. Tube mills show a high rate (3.58 days) for injuries to parts of the head and for those to the thorax (3.64 days), due to machinery. Sheet rolling mills have marked severity for injuries from handling objects, which are naturally located on hands and fingers. The fabricating department

[16] See pp. 83 to 87.
[17] See Chap. V.
[18] See pp. 88 to 103.

suffers most from injuries due to machinery, injuries to the thorax being most important (3.66 days). In the electrical department injuries from machinery are the most severe, those to the skull (9.62 days) being the most serious. Mechanics are most seriously injured by machinery, particularly in accidents to the thorax (4.06 days). Yard employees are sufferers particularly from injuries to the thorax (16.51 days), caused by vehicles.

CAUSES AND NATURE OF INJURY.[19]

Blast furnaces.—The machinery of this department causes fractures (7.26 days) and crushing injury (3.57 days) of most noteworthy severity. Asphyxiating gas (9.14 days), included under "unclassified causes," appears here, as elsewhere, as a serious hazard.

Bessemer.—The effect of hot substances, including electricity, is shown by the rate for burns (23.99 days). Next in order come vehicle accidents causing crushing injury (12.36 days) and machinery causing crushing injury (11.38 days).

Open hearths.—Burns arising from hot substances and electricity have the highest rate (16.61 days) in this department.

Foundries.—Hot substances producing burns (7.00 days), machinery causing crushing injury (6.59 days), and machinery causing fracture (3.83 days) are the noteworthy items for foundries.

Rolling mills.—The highest rates in the several types of rolling mills are, for heavy rolling mills, hot substances producing burns (5.45 days); for plate mills, machinery producing fractures (7.52 days); for tube mills, machinery producing crushing injury (6.50 days); and for sheet rolling mills, handling objects or tools producing laceration (1.81 days).

Fabricating.—Crushing injury due to machinery (7.93 days), fracture due to machinery (5.43 days), and crushing injury due to falling objects (2.19 days) are serious rates in fabricating.

Electrical.—Machinery causing crushing injury (15.43 days), machinery causing fracture (14.76 days), and shocks by the electric current (14.32 days) contribute largely to severity in this department. The hazard of electric shock is very characteristic, though not confined to this department. One group of employees, the linemen, are particularly liable to falls resulting in fractures (10.44 days).

Mechanical.—The mechanics have suffered during this period conspicuously from crushing injury due to machinery (5.10 days) and falls of worker resulting in fracture (3.64 days).

Yards.—Crushing injury caused by vehicles (35.71 days) stands out above all others in this department.

CAUSES AND RESULTS OF INJURY.[20]

Results of injury are classified under three headings—"Death," "Permanent disability," and "Temporary disability." When presented by means of frequency rates the figures increase in the order named. This inevitably conveys an impression of importance related to the size of the figure. For example, if the death rate is 0.8 cases per 1,000,000 hours' exposure, permanent disability 2.5 cases, and temporary disability 35.0 cases, it is difficult not to think of tem-

---

[19] See pp. 103 to 111.

[20] See pp. 111 to 120.

porary disability as being not only more numerous but also of larger significance.

On the other hand, when in blast furnaces the death rate is stated to be 10.22 days per 10,000 hours' exposure, permanent disability 3.72 days, and temporary disability 0.58 day, the impression given by the relative size of the figures is the proper impression and no mental correction is necessary to give them a true perspective.

The severity rates for the various departments of the iron and steel industry for the period 1915 to 1919 classified by causes and results of injury are shown in Table 38.

VARIOUS RELATIONS OF LOCATION, NATURE, AND RESULTS OF INJURY.[21]

The causes of injury and how they are related to the departments and to the worker have been considered. Besides these relations, which are of rather fundamental importance in seeking a solution of the accident problem, there are a number of interrelations which shed light on various portions of the field.

These can not be summarized to any advantage but will be found in detail in Tables 39 to 46.

HUMAN FACTORS IN CAUSING AND PREVENTING ACCIDENTS.[22]

Three human factors influence more or less directly the occurrence of accidents, namely, the management, the foreman, and the worker himself. An effort has been made to investigate the nature of this influence and to suggest ways in which satisfactory results may be attained.

THE MANAGEMENT.

Since the influence of this factor can not be readily presented in a statistical manner it is not treated with great fullness. It is beyond question more important than this summary dismissal of it would indicate. A management in full sympathy with the safety movement and devoting to it the same sort of attention as that given to production is sure to get results. These may be expected to correspond to the efficiency of the organization as a going concern. If the production end is handled well, the safety feature will be apt to share in the general prosperity.

THE FOREMAN.

The importance of the foreman has been emphasized from the beginning. Judged by results obtained no experiment deserves more critical attention than that of offering an accident reduction bonus to foremen.

An attempt has been made to develop the facts regarding a test of the foreman's accident reduction bonus on a fairly large scale and covering a considerable period of time. The conclusions which seem justified are the following: 1. A foreman's bonus for accident reduction will very greatly reduce minor injury; 2. Such a bonus will not necessarily produce satisfactory results as to severe injury. In fact, unless coupled with active use of other measures, the tendency will be to a stationary or rising severity rate.

---

[21] See Chap. VI. [22] See Chap. VII.

THE WORKERS.

The very qualities which make a worker adaptable in industry will at times lead to his doing things which materially increase his hazard. Conditions of mind and body entirely out of the control of the worker may influence his accident rate. The results of these various conditions are set forth with some particularity on pages 167 to 191.

Inexperience.—Wherever it has been possible to isolate groups of relatively inexperienced men[23] it constantly appears that accident rates are in some degree proportional to the lack of experience on the part of the worker. Whenever the "new-man accession rate" is high, accident rates will rise, and a decline nearly always sets in whenever the "accession rate" begins to decline.[24] Extreme inexperience[25] is particularly likely to show high accident rates.

Selective discharge.—Whenever business depression comes on the less desirable men will be the first to go. The result will be a force of relatively greater experience and of more reliable character. This influence must be quite important in the lowered accident rate of periods of depression.

Geographic location.—Some plants in which safety work of high grade has been done appear constantly to have a higher accident rate than others in which safety work of no better quality is being done. It has often appeared that such plants were so located that they were in the nature of "ports of entry" to the steel business and on this account had a larger contingent of inexperienced men.

Influence of age.[26]—The diversity of occupation which is very likely to be characteristic of different age groups makes it extremely difficult to determine whether age is an important factor in determining accident rates. The available information seems to indicate that in age groups whose duties are tolerably similar the group of less experience will have the higher rate.

Ability to speak English and accident rates.[27]—Whenever it has been possible to isolate and contrast groups which could and could not speak English, the group which had not acquired the language had the higher accident rates. It may be seriously questioned whether this defective knowledge was the main factor in the higher rate. It must have some influence, but these non-English speakers are also without experience, and that lack may be more important than their deficiency in the matter of language.

Day and night accident rates.—Evidence is abundant that in heavy employments the night turn is more dangerous than the day turn. Two influences immediately suggest themselves as responsible for this condition: (1) Imperfect lighting and (2) a condition of the worker rendering him more liable to accident. It is evident that developments in the direction of more adequate lighting and tending to improve the physical condition of the worker have had a salutary influence.

Conjugal condition.—If the attitude of the worker in the matter of personal care is the main factor in the determination of accident rates, then those married and having dependents might be expected to show lower rates. The only case where it has been possible to examine any considerable body of data yields negative results. No constant and significant differences can be discovered.

[23] See Table 50.
[24] See Chart 10.
[25] See Tables 51 and 52.
[26] See Table 53.
[27] See Table 56.

Use of alcohol and accident rates.[28]—There is very great difficulty in determining a point like the influence of the use of alcohol upon accident rates. It is comparatively simple to isolate the cases due to some physical cause such as machinery. If a man is caught and crushed the fact becomes a matter of record. What his physical condition was at the same time, due either to alcohol, loss of sleep, or domestic worry, it is almost impossible to determine, and it is still more difficult to reach a conclusion regarding the degree to which this condition contributed to his injury.

In one plant some records were found which appeared to bear directly on the question of the influence of alcohol. The extent to which discipline had been administered for alcoholic indulgence had been recorded. When these records were put in the form of rates, it was evident that such disciplinary action had been much more frequent on the night turn. The night accident rates were higher. When the two sets of rates were compared over a series of years, it appeared that both disciplinary action and accident rates in the night turn had been declining in close parallelism. The conclusion would seem well founded that the lessened alcoholic indulgence evidenced by the declining disciplinary rates was a factor in the corresponding decline of accident rates.

It is probable, but not statistically demonstrable, that the fact that rates did not rise so high in the war period as in the preceding interval of industrial stress in 1913 was due in part to the restrictions applied to the dispensing of alcoholic drinks.

Distribution of accidents through the working hours.[29]—Tabulation of the hour-to-hour distribution was originally undertaken in the hope that it would shed some light upon the question of the influence of fatigue in industry. To the compilations hitherto made figures for the five-year period 1915 to 1919 have been added, but this new material serves simply to emphasize the conclusion that in such mills as those of the iron and steel industry other factors are so much more influential that the fatigue factor is completely masked.

The United States Public Health Service issued a bulletin (No. 106) in February, 1920, discussing accident distribution and the influence of fatigue. It may be said that this study goes far toward establishing, in certain types of activity, a constant relation between fatigue, output, and accident occurrence.

"ENGINEERING REVISION."[30]

It has commonly been assumed that there is such a thing as an "irreducible minimum" of accidents which safety effort would finally reach and below which it could not be expected to go. The first thing to suggest that such an expectation was not as favorable as it might properly be was the study of severity rates. It then appeared that in getting rid of cases of high severity application of engineering skill had been not only an important factor but probably the most important factor.

For example, consider the experience in blast furnaces. In the earlier days a very large contribution to severity arose in connection with hot-metal "breakouts." In one furnace such an event caused the death of 14 men. As the rates from breakouts are followed from

---

[28] See Table 60. [29] See Table 61. [30] See Chap. VIII.

year to year it is possible to trace a steady decline in severity related to a progressive increase in strength of construction of the furnaces. Finally, in the group of furnaces whose results were considered, "breakouts" came practically to an end. As a result of this, the severity rate was diminished by 19.6 days per 1,000 hours' exposure when 1906 and 1913 are compared. On the other hand, causes depending largely on personal care, such as "handling tools," made a very meager contribution to the declining severity rate. Contrast a diminution of 19.6 days in severity rates which was due to the "engineering revision" which stopped "breakouts" with 2.4 days in "handling objects and tools." A part of this reduction in "handling objects and tools" must be attributed to improved form and care of tools.

If it be accepted that "engineering revision" is the main reliance in the effort to get rid of severe injury, no limit can be set. Human carefulness can not be immediately perfected, but physical conditions can be to the point of making serious injury of rare occurrence. This conclusion is reinforced by a study of fatal cases and the nature of the injury which caused them. Most important is the result arrived at by studying the records of safety committees. In one group of accidents it was found that 57 per cent of severe cases were amenable to prevention by engineering methods and in another group 65 per cent. The increasing use of men having an engineering training in the handling of safety problems should have an important bearing on the reduction of severe injury.

THE ACCIDENT RECORD TO 1920.

The accident record of the several departments up to 1919 is presented in Chapter IX in various forms. In each case there is a tabular record which includes the number of full-year workers covered in each of the years, the number of accident cases, classified by deaths, permanent disabilities, and temporary disabilities, and the accident rates, both frequency and severity. On the basis of this table and other available information three charts are presented for each department whenever possible. The first of the charts shows the severity rates for the years 1910 to 1919, including also the year 1907 whenever possible; the second shows the percentage of change in both frequency and severity rates from year to year for the decade 1910 to 1919; the third presents the result of "smoothing" the curves by using a five-year interval terminating with each year from 1911 to 1919.

The industry.[31]—Two points noticeable in the industry are found in many of the departments thereof: (1) The rates for the year 1907, which antedates any well-organized effort toward safety, exceed those of any later year in every particular; (2) the years of high industrial activity show rising accident rates. The high points in the rates per 1,000 hours' exposure are 1907 (7.2 days), 1910 (5.2 days), 1913 (4.3 days), and 1917 (4.0 days).

The fluctuation chart shows that between these high points, forming an irregular declining series, are periods of low rates corresponding

[31] See Table 65 and Charts 15 to 17.

to industrial depression. The trend chart indicates a very steady downward movement in frequency and a similar but less regular decline in severity.

Blast furnaces.[32]—This department presents the most marked contrast between the year 1907 and later years. It is a little disquieting to observe that while the general trend has been downward to the five years ending 1918 the yearly rate during the five-year interval 1915 to 1919 goes steadily up and reaches in 1919 the same level as in 1912 and 1913. This can not continue without seriously impairing what has been an excellent record.

Interesting contrasts between the different blast-furnace occupations are presented. The second five-year period (1915 to 1919) shows a marked change for the better in each occupation. This is especially the case with cast-house men and appears to be related to changes in structure and method which lessen the hazard of burns.

Bessemer.[33]—In this department the record is very erratic and the second five-year period has a slightly higher severity rate (6.9 days) than the first (6.4 days). The low severity of 1907 (5.4 days) is doubtless due to the fact that the exposure was small and in plants which even then had conditions better than the average.

Open hearths.[34]—The five-year period 1915 to 1919 has a slightly lower severity (6.5 days) than the five-year period 1910 to 1914 (6.6 days). The war period shows a rather violent rise both in frequency and in severity. This was sufficient to produce an upward trend of severity for the years 1918 and 1919. Severity ranges from the high rate of 1907 (14.4 days) to the low rate of the years 1915 and 1916 (4.2 days).

Foundries.[35]—Severity having been constantly lower in foundries, it may be that the need of effort has not generally impressed those responsible for this industrial group. The severity rates run an erratic course and when subjected to the smoothing process do not indicate any fundamental improvement. That this failure to improve is not necessary is shown by the experience of a group of plants in which it was possible to determine for the two 5-year periods the occupational rates. For each occupation except melters and their helpers, the rate is less in the second period than in the first. For the melters the rate is the same in both periods (2.4 days).

Heavy rolling mills.[36]—The second five-year period shows a higher severity rate (3.9 days) than the first (3.6 days). It is evident, however, on observing the fluctuation chart and the trend chart, that some material improvement has occurred. The war period had a marked influence in forcing the severity rates up, but this was not sufficient to offset declines which had previously occurred.

Plate mills.[37]—These mills show a remarkably regular decline over the period prior to the war. The severity rate drops from 6.6 days in 1910 to 1.9 days in 1915. Following the year 1915 is the usual rise which is so constantly associated with the beginning and progress of the war. The peak is reached in 1918 (3.0 days).

Sheet mills.[38]—These mills present the most consistently declining rates of any department. Over the 10 years, 1910 to 1919, the

[32] See Table 66 and Charts 18 to 20.
[33] See Table 68 and Charts 21 to 23.
[34] See Table 69 and Charts 24 to 26.
[35] See Table 70 and Charts 27 to 29.
[36] See Table 73 and Charts 30 to 32.
[37] See Table 74 and Charts 33 to 35.
[38] See Table 77 and Charts 36 to 38.

severity rate drops from 4.3 days to 1.1 days. The two 5-year periods have rates of 2.6 days and 1.5 days.

Tube mills.[39]—These mills present a mixture of processes which renders the rates somewhat uncertain. The rolling of the tubes presents hazards much like those of the ordinary rolling mill, while the finishing, which involves cutting the tubes into lengths and threading the ends, is essentially a machine-shop operation. It is in part this element of machine-shop hazard which accounts for the relatively low rates of the department. The severity rates have been highly irregular, but when the two 5-year periods are compared they show rates of 2.2 days and 1.8 days respectively.

Unclassified rolling mills.[40]—These mills vary considerably but are largely of hand-operated types. The severity rate of the first 5-year period (3.7 days) is noticeably higher than that for the second (2.1 days).

Fabricating shops.[41]—These shops make great use of overhead cranes and have a high severity rate from that cause. The rate for the five years 1910 to 1914 is 3.4 days, and for 1915 to 1919 is 2.6 days.

Wire drawing.[42]—Due to accidents resulting from entanglement in the wire as it is drawn toward the block, this department shows unusual severity in permanent injuries. Severity in the two 5-year periods is 3.2 days in the first period and 2.6 days in the second.

Electrical department.[43]—The record for this department is a serious disappointment. It shows a rather high severity and the department does not seem to have made any progress. For 1910 to 1914 the rate is 6.3 days and for 1915 to 1919 it is 7.2 days. The fluctuation chart shows a great decline during the depression prior to the war, with an immediate rebound to a point as high as in the prewar days. It has been demonstrated that the department can be conducted more safely than this record suggests. One considerable group of plants which has been studied regarding causes of accident has a severity rate of 5.2 days per 1,000 hours' exposure instead of 7.2 days. With this group removed from the total the rate of the remainder would be still higher.

Mechanical department.[44]—The earliest year for which a rate could be determined was 1908 (6.6 days). The rate for the second five-year period (3.5 days) is distinctly lower than the rate for the first period (4.0 days). The fluctuation chart shows frequency and severity running a much more nearly parallel course than is the case with some of the departments. There is reason to believe that fatal injury is more frequent among the mechanics than would be the case if physical conditions were made as good as they should be.

Yards.[45]—This is another department which it must be admitted does not record any material improvement. The rates for the 5-year periods are almost identical (6.0 days in 1910 to 1914 and 6.1 days in 1915 to 1919). It has been elsewhere pointed out that the department presents peculiar difficulties in the fact that many plants have outgrown the space to which they are confined. This situation produces a congestion of transportation operations particularly troublesome to the safety man.

---

[39] See Table 78 and Charts 39 and 40.
[40] See Table 79 and Charts 41 and 42.
[41] See Table 80 and Charts 43 and 44.
[42] See Table 82 and Charts 45 and 46.
[43] See Table 83 and Charts 47 and 48.
[44] See Table 84 and Charts 49 and 50.
[45] See Table 86 and Charts 51 and 52.

Erection of structural steel.[46]—The rates here recorded for this department demonstrate conclusively that the structural-steel workers are exposed to a more serious hazard than any other industrial group. The severity rate due to fatality is 18.1 days per 1,000 hours' exposure. This may be contrasted with brakemen in railway yards (16.6 days), road freight brakemen (14.1 days), electrical workers (5.7 days), and blast-furnace employees (4.7 days). The five years 1915 to 1919 show a marked improvement over the 3-year period 1912 to 1914. The general severity rate declined from 31.4 days to 22.3 days. The work is difficult to deal with from the safety standpoint, but this record and the experience of construction companies prove that much can be done.

Other departments.[47]—A tabular record of the following departments is shown on pages 272 and 273 without comment: Coke, armor plate, axle works, car wheels, docks and ore yards, fence weaving, nails, and unclassified.

A new accident standard.[48]—It seemed, when the records were finally brought together for the five years 1910 to 1914, that they were sufficiently extensive to be regarded as a fair standard by which the industry and its departments could be measured. The rates reflected the average experience for the period covered. While some of the departments show higher rates in the later period, it seems on the whole appropriate to displace the rates of the earlier period by this later showing. To equal the average of the industry ought not to be regarded as a particularly honorable achievement; to better it will help in establishing that still higher standard which ought to be worked out; to fall below it may be misfortune or it may be indifference and inefficiency.

THE WAR AND ACCIDENT RATES.[49]

Constant reference appears throughout this report to the influence of the war period. It has been possible to present a series of conditions which bring out with especial vividness the characteristic fluctuations which obtained during the war.

Basic departments.—A picture of the course of events in a large group of establishments is provided by Charts 54 and 55. These were chosen because both frequency and severity could be determined. Frequency both for nondisabling and disabling accidents was very irregular from month to month as shown in Chart 54, but the extreme of fluctuation is found in the severity rates. In order to make the trend more evident, in Chart 55 the curves have been "smoothed." This brings out the fact that from the year ending December, 1914, there was a decline for some time, followed by a marked rise extending throughout the period in which industry was adjusting itself to the war burden. A second period of rising severity rates, extending to the year ending November, 1918, may represent unusual industrial activity. Unfortunately it was not possible to show on the chart years back far enough to show that this war-time peak was not as high as that of 1913. This becomes evident in Chart 56 which presents simply the employment and the accident frequency curve.

---

[46] See Table 87 and Chart 53.
[47] See Table 88.
[48] See Table 89.
[49] See Chap. X.

Plants producing various products.—It having been shown that a certain general course of accident rates characterized the industry during the disturbance due to the war, it becomes important to inquire whether all forms of production share in this tendency or whether some may be of sufficient weight to control the curves against a different course for others. In Chart 57 it is shown that all the chief forms of production were influenced in practically the same way.

Effect on the various causes.—A third test may be applied by following the various causes from year to year. This may be done in Table 94. In this table it is shown that each of the principal cause groups and most of the subordinate causes run a similar course. It may be concluded that while war conditions disturbed industry exceedingly they introduced no new factors into the situation. The sort of effort which had proved effective under ordinary conditions was likewise adapted to produce results under war conditions if applied with an energy proportioned to the situation.

STATISTICAL METHODS FOR THE SAFETY MAN.[60]

In Bulletin No. 234 a chapter was devoted largely to the presentation of safety organization. It has been suggested that in this report the subject be still further elaborated. The available literature for the guidance of the safety man is now so extensive and readily available that it does not seem necessary to attempt a summary of it here, and accordingly only those statistical methods which have been found useful in the course of the bureau's accident studies are considered.

Forms and methods in use by the Bureau of Labor Statistics.—The facts regarding accidents are best presented by means of rates of various sorts. These are essentially ratios between the exposure to hazard expressed in terms of hours, regarded as a base, and the number of accidents, the equivalent time losses, and such other items as it may be desired to study. The necessary information regarding exposure is gathered annually upon a blank on which "man-hours" are entered, or, if they are not a matter of record, information regarding number of men, days of operation, and length of day or turn, from which "man-hours" may be computed.

For accidents two methods of reporting are in use: (1) Tables classifying the occurrences by departments and by the character of the result, such as death, loss of hand, or temporary disability of varying duration, and (2) records of individual cases entered upon a card on which are spaces for such items as age, sex, cause of accident, nature of injury, etc. A portion of each card is arranged for the entry of code numbers, into which the information mentioned above is translated. When the translation into code is completed the numbers are transferred to punched cards, which can be sorted and tabulated with great rapidity by means of sorting and tabulating machines.

Records and charts.—The safety man must often present the facts to the management in such form as to arouse interest and afford information regarding the results of his efforts. For this purpose he uses tabulations and more frequently some form of chart. When

[60] See Chap. XI.

it is desired to compare absolute amounts some form of bar chart is used, preferably with the bars horizontal (e. g., Chart 15).

In order to follow the trend of events without the disturbance due to local and temporary conditions it is often desirable to employ some "smoothing" process. This is usually accomplished by introducing between the figures for the successive calendar years a series of figures for the years terminating with each month. In this way each point determined on the chart represents not an individual month but a full year.[51] The "smoothing" process is adapted to the study of accident causes as well as to the departmental data.[52] For the study of the changes occurring in accident rates the comparison of absolute amounts such as is possible by means of arithmetic tables and charts is not adequate. It is usual to express rate changes in terms of percentage; for example, a 50 per cent rise or a 30 per cent fall. Some form of graph which projects these percentage changes is needed. This is afforded by the "ratio chart."[53]

[51] See Charts 54 and 55. [52] See Chart 60. [53] See Charts 58 and 59.

CHAPTER II.—PREPARATION AND USE OF RATES IN THE STATISTICAL STUDY OF INDUSTRY.

THE DETERMINATION OF A PROPER BASE.

The rates which form the subject matter of vital statistics—namely, birth and death rates—have long been familiar. The base used in computing them is the population of the area under consideration. For example, a city having 100,000 population in which 1,500 deaths occurred in a certain year would be said to have a death rate of 15 per 1,000 population. When industrial matters, such as accidents, came to be considered from a statistical standpoint it was natural, even inevitable, that a similar basis would be chosen.

In the early attempts at accident statistics, attention was limited to the number of accidents occurring in a given plant or group. But mere numbers, of course, meant nothing unless related to the number of persons exposed to accident. This led to the custom of expressing accidents in terms of so many per thousand workers, and constituted an approach to a correct method. To say that a given industry had an accident rate of 100 per thousand workers does convey a definite idea, and can be compared with a rate of, say, 300 per thousand workers in another industry. But the method was extremely crude, because the basic figure "1,000 workers" was indefinite and variable. Usually it was derived by rough estimate as to the number of persons employed, such as averaging the number employed at different times of the year or averaging the pay rolls of the year.

It very soon became evident that not only must the number of persons in the working force be considered, but also the amount of time which they spend in the industry. It is perfectly clear that a plant which has 1,000 employees and works 200 days in the year stands on a different level in the matter of exposure to industrial hazard from one in the same line of business and having the same number of employees which works 250 days in the year.

In order to meet this necessity of taking into account the time element and at the same time preserving the idea of comparison with the number of people working, the "full-year worker" or "300-day worker" was devised.

This theoretical person, for use as a standard of measurement, is formed on the idea of equivalence. Five men working 10 days are equivalent to 10 men working 5 days or 2 men working 25 days or 1 man working 50 days. In the plant cited above the 1,000 workers for 200 days are equivalent to 1 worker for 200,000 days. If 300 days be assumed to be a full working year, dividing the 200,000 by 300 gives 667 as an equivalent in terms of "full-year" or "300-day" workers. Treating the other plant, which had 1,000 workers but was in operation 250 days, in the same manner the equivalent number of "full-year workers" will be found to be 250,000 divided by 300 or 833. On comparison of the numbers 667 and 833 it becomes evident at once that the second plant had a larger exposure to the hazards of the industry than the first and could have a proportionately larger number of accidents without showing greater hazard.

If we suppose that Plant 1 had 100 accidents while Plant 2 had 112, on the basis of number of employees the rates would be 100 and 112 per 1,000 employees, respectively. When, however, "full-year workers" are used the rates become for Plant 1 $\frac{100}{667}\times 1{,}000=150$ per 1,000 "full-year workers" and for Plant 2' $\frac{112}{833}\times 1{,}000=134$. When the factor of time is brought in it becomes evident that Plant 1 rather than Plant 2 had the greater hazard in the proportion of 150 to 134.

The method of determining a base outlined above and used for a time fails to take into account the fact that an industrial day is not a constant. A department which operates 12 hours per day has a different exposure from one which operates 8 hours per day. To meet this difficulty the number of "man hours" instead of "man days" was taken as the basal figure and this was converted into an equivalent in terms of "full-year workers" by dividing by 3,000.

The "full-year worker," as described and illustrated above, had been long in use as a standard of measurement in Germany and Austria and had received an international sanction from a joint committee of the International Congress on Social Insurance and the International Institute of Statistics when the United States Bureau of Labor Statistics began its accident studies. This base has been used in all the publications on the subject to the end of 1919 and was formally indorsed by the committee on statistics and compensation insurance cost of the International Association of Industrial Accident Boards and Commissions in 1917.

There has always been a certain amount of difficulty in the practical use of this base in making perfectly clear what was meant by it and what its relations were to the ordinary expressions of employment. Lately there has arisen a further objection on the ground that its use implies some judgment regarding the proper length of a working day.

After prolonged and careful study the committee on statistics and compensation insurance cost of the International Association of Industrial Accident Boards and Commissions has reached the conclusion that it is desirable to break away entirely from the idea of representing the number of employees in the base used. The action taken is given in the following resolution and the accompanying explanation:

Resolved, That accident rates, both frequency rates and severity rates, be computed on the basis of 1,000 hours' exposure instead of 3,000 hours' exposure, as heretofore.

The unit of measure for both frequency and severity accident rates which has come to be generally used is the "300-day worker," sometimes called "full-year worker." This hypothetical worker is supposed to work 10 hours a day for 300 days in the year, or 3,000 hours per year.

The committee on statistics and compensation insurance cost at its first meeting considered very carefully the question of a proper unit for measuring accident rates and decided to adopt the only unit then in actual use, namely, the "300-day worker."

The "300-day worker" was chosen as the standard measure for accident rates because (1) it is absolutely necessary to have some common unit for measuring accidents in all occupations, all industries, all States, and all countries. (2) The "300-day worker" had been recommended as the standard unit for computing accident rates by the Permanent International Committee on Social Insurance and the International

Institute of Statistics and was in use in Germany and Austria and by the United States Bureau of Labor Statistics at the time the committee on statistics took up the matter of standardization of accident statistics. (3) It was alleged that most workers did work about 10 hours a day and about 300 days in the year. It was further argued that while the "300-day worker" did conform closely to the normal worker, still he was merely an abstraction, a unit of measure, and would measure exposure to accident just as accurately for an 8-hour day as a 10-hour day, for a 200-day year as a 300-day year. The use of this unit, it was maintained, did not suggest a 10-hour day or a 300-day year as the ideal and proper working day and industrial year.

In fact both employers and employees do regard the "300-day worker" as suggesting what the ideal working day and working year should be. The secretary of the National Safety Council has pointed out that the 8-hour day is becoming the standard working day and suggested that the unit measure be made 2,400 hours per year instead of 3,000 hours so as more nearly to reflect the yearly working time. A 2,000-hour year was also considered by the committee on statistics and compensation insurance cost, but it was recognized by all members of the committee that any standard unit of measure which suggested the length of time men do or should work is undesirable.

In view of the fact that the working time, both the hours per day and the days per year, varies widely from plant to plant, from industry to industry, from city to city, from country to country, and from year to year, it was thought best by the committee to cut loose entirely from a unit of measure that could be misunderstood as in any way implying what the proper working time should be. The adoption of 1,000 hours' exposure rids us forever of any such implication and gives a unit which is convenient in size and will remain unaffected by changes in the working day or variations in the working year. The 1,000-hour exposure is a stable, scientific, mathematical unit of measure, which is what is needed for the measurement of accident rates. It has the further advantage that accident rates measured by any other unit of exposure may be readily expressed in terms of the 1,000-hour unit and vice versa. For instance, all accident rates computed in units of the "300-day worker" may be converted into rates per 1,000 hours' exposure by dividing by 3. Frequency rates are to be expressed in rates per thousand thousand (1,000,000) hours' exposure of the working force instead of per thousand "300-day workers." Severity rates are to be expressed as days lost per thousand hours' exposure of the working force instead of days lost per "300-day worker." In both instances the new rates can be derived from the old rates by dividing by 3.

This base for computation of accident rates has important advantages beside those mentioned in the preceding statement by the committee on statistics. Not the least of these is that since the number of hours of exposure mentioned and others which could be chosen are decimally related to each other, it is possible to diminish or increase the base without altering the figures in the rate, the only change being a shift in the decimal point. For example, a severity rate of 1.11 days per 1,000 hours' exposure becomes 11.1 per 10,000 hours' exposure or 111.0 per 100,000 hours' exposure. When an extended analysis (for example, such as may be necessary in the study of accident causes) is undertaken, it may be very desirable to increase the base in order to avoid lengthy decimals. To be able to do this, as indicated above, without disturbing the significant figures of the rate is a very great advantage.

OBTAINING "MAN-HOURS."

In those establishments which keep accurate records of the hours worked by each employee each day, the man-hours worked by the establishment can easily be obtained from the records. Few small establishments, however, keep any such accurate records of time worked. For the majority of small plants it is necessary to compute the number of man-hours worked. The method suggested by the conference called by Commissioner Meeker, which met in Chicago October 12 and 13, 1914, was as follows: "If this exact information is not available in this form in the records, then an approximation should be computed by taking the number of men at work (or enrolled) on a certain day of each month in the year and the average of these numbers multiplied by the number of hours worked by the establishment for the year would be the number of man-hours measuring the exposure to risk for the year."

DEFINITION OF "ACCIDENT."

Having determined upon a reasonable base of reference, it becomes necessary before rates can be computed to have some clear-cut idea of what shall be included under the term "accident."

What, then, is to be regarded as an industrial accident for the purposes of statistical study? No definition has as yet been universally accepted. Some establishments and States attempt to take account of all injuries, however trivial. Others exclude those of a minor character and take account only of such as cause a loss of a specified amount of time. It is evident that the accident showing of a plant may be completely altered by a change in definition of accident, and that in the absence of a uniform definition all comparisons between the accident data of different plants, industries, or other groups become almost worthless. The precise definition is not so important. The important thing is that the same definition should be everywhere observed.

The most significant step so far taken toward such uniformity in this country is the action of the International Association of Industrial Accident Boards and Commissions in adopting a definition of "tabulatable accidents"—i. e., a definition not necessarily to be followed in the original reporting of accidents, but to be used in all statistical tabulations. The definition is substantially the same as the one long used by the Bureau of Labor Statistics in its accident investigations and employed in the present report, and is as follows:

Tabulatable accidents, diseases, and injuries.—All accidents, diseases, and injuries arising out of the employment and resulting in death, permanent disability, or in the loss of time other than the remainder of the day, shift, or turn on which the injury was incurred, should be classified as "tabulatable accidents, diseases, and injuries," and a report of all such accidents, diseases, and injuries to some State or national authority should be required.

The States which are members of the International Association of Industrial Accident Boards and Commissions are thus committed to a uniform standard definition of the accidents which are to be tabulated. Some States may at first find it impossible to tabulate all accidents as required by the definition, but the desirability of doing so is apparent, and many have already made a beginning.

ACCIDENT FREQUENCY RATES.

Two elements, namely, hours of exposure and cases of accident, defined as above, may now be brought together and a ratio established between them. This will give an accident frequency rate. For example, in a large steel plant in the year 1913 the hours of exposure numbered 22,686,000 and the accident cases 866. Dividing and adjusting the quotient per 1,000,000 hours' exposure gives a frequency rate of 38.2. In 1912 the machine building concerns studied in that year had an exposure of 347,109,000 hours and 13,653 accidents. This is at the rate of 39.3 cases per 1,000,000 hours' exposure.

Comparing these rates it is correct to conclude that accidents were less frequent in the iron and steel industry than in machine building in the proportion of 38.2 to 39.3. All differences in hours of labor, number of days worked, etc., in the two industries have been duly taken into account. Again, if a given plant shows an accident frequency rate of 33.3 one year and 30 the next, it is a correct conclusion that accidents have decreased 10 per cent in frequency.

Frequency rates of this character were computed and used in the report on accidents in the iron and steel industry, issued by the Bureau of Labor Statistics in 1913 and in Bulletins Nos. 216, 234, and 256.

The method was found practicable and, within limits, highly useful. But it had one serious weakness, namely, that frequency rates, as the name indicates, measure the frequency of accidents, but take no account of the severity of the resulting injuries, and experience has shown that the two things do not necessarily move in the same direction. The frequency rates may be the same in two plants in the same industry, and the hazards may be entirely different because one plant has very few severe accidents, while the other has a large proportion of serious accidents. To put all industries and all plants on a common basis, a system of computing accident rates must be devised which will take into account the difference in economic significance between the accident which bruises the workman's thumb and the accident which breaks his back.

ACCIDENT SEVERITY RATES.

What is needed is some method of weighting injuries according to their severity. Several methods suggest themselves as possible—compensation paid, wage loss, or time loss. A compensation system necessarily weights the importance of accidents in fixing a scale of benefits which aims to apportion the payment to the hurt. But compensation payments do not offer the universal measure desired because the benefits differ from State to State and are also subject to change within the same State. Wage loss due to injury offers perhaps a better measure of severity, but this, too, suffers from the handicap that wages differ from place to place and from time to time. Time loss as a measure does not suffer from these objections. An accident that causes 6 days' disability is precisely twice as serious as one causing only 3 days' disability, and this relation is always and everywhere the same.

The days lost because of injury may thus be taken as the most satisfactory measure of the true hazards of industry—of the burden imposed upon the worker and the community because of industrial accidents. The only difficulty in its practical application is that in case of death and permanent injuries the time lost must be estimated. For temporary disabilities, from which recovery is complete, the time losses are matters of record—2 days, 10 days, 6 weeks, as the case may be. But if the accident results in death, the time loss is not so clearly measurable. It exists, however, and may be estimated as the number of working days by which the worker's life was curtailed. Similar estimates are possible in case of permanent injuries, such as loss of hand or foot.

The schedule of weightings finally adopted by the committee on statistics is as follows: [54]

SCALE ADOPTED BY THE INTERNATIONAL ASSOCIATION OF INDUSTRIAL ACCIDENT BOARDS AND COMMISSIONS.

Result of injury.	Degree of disability in per cent of permanent total disability.	Days lost.
Death	100	6,000
Permanent total disability	100	6,000
Arm above elbow, dismemberment	75	4,500
Arm at or below elbow, dismemberment	60	3,600
Hand, dismemberment	50	3,000
Thumb, any permanent disability of	10	600
Any one finger, any permanent disability of	5	300
Two fingers, any permanent disability of	12½	750
Three fingers, any permanent disability of	20	1,200
Four fingers, any permanent disability of	30	1,800
Thumb and one finger, any permanent disability of	20	1,200
Thumb and two fingers, any permanent disability of	25	1,500
Thumb and three fingers, any permanent disability of	33⅓	2,000
Thumb and four fingers, any permanent disability of	40	2,400
Leg above knee, dismemberment	75	4,500
Leg at or below knee, dismemberment	50	3,000
Foot, dismemberment	40	2,400
Great toe, or any two or more toes, any permanent disability of	5	300
One toe, other than great toe, any permanent disability of	0	....
One eye, loss of sight	30	1,800
Both eyes, loss of sight	100	6,000
One ear, loss of hearing	10	600
Both ears, loss of hearing	50	3,000

This schedule supplies a series of constants by which death and permanent injuries may be weighted in terms of a common unit—time lost in days—which is also the same unit as that used for measuring temporary disabilities. By multiplying the number of deaths and permanent disabilities by the time lost determined for each and adding the products to the days lost through temporary disabilities, a figure is obtained which represents the total days lost from injuries. Dividing this number, representing total days lost, by the number of hours of exposure and multiplying the quotient by 1,000, will give the number of days lost per 1,000 hours' exposure. This result may be called an accident severity rate.

The entire process of working out a general severity rate for a plant may be illustrated as follows: A certain plant shows a total of 4,200,000 "man-hours" in the course of a year. The kind of injuries occurring and the time allowances according to the committee's scale are presented in the following table:

[54] For complete discussion of the subject see Bulletin No. 276 of the United States Bureau of Labor Statistics, pp. 71–77.

ACCIDENTS AND TIME LOSSES IN ONE PLANT.

Cases.	Time losses.	
	Per case.	Total.
	Days.	*Days.*
1 death	6,000	6,000
2 arms lost	[1] 4,000	8,000
1 foot lost	2,400	2,400
5 thumbs lost	600	3,000
25 fingers lost	300	7,500
290 temporary disabilities		2,790
Total (324 cases)		29,690

[1] Instead of using two classifications, with allowances of 3,600 and 4,500 days, for the loss of an arm as in the committee's scale, a single classification, with an allowance of 4,000 days, is used throughout this report.

The total number of days lost (29,690) divided by the hours of exposure (4,200,000) gives a rate of 7.1 days per 1,000 hours' exposure. The accident frequency rate for the same group per 1,000,000 hours' exposure is 77.

ILLUSTRATIONS OF SEVERITY RATING.

The preceding paragraphs have explained the meaning of accident severity rates and the method by which they are obtained. The significance of such rates in their practical application is indicated in the two following illustrations.

In Table 1 comparison is made of the accident experience for a year of the iron and steel industry, as represented by a large plant, and of the machine-building industry, as represented by a group of plants. Frequency rates and severity rates are shown in parallel columns.

TABLE 1.—ACCIDENT RATES IN STEEL MANUFACTURE AND MACHINE BUILDING.

Industry.	Number of workers.	Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Iron and steel (1913)	7,502	0.6	1.5	36.0	38.1	5.5	0.7	0.8	7.0
Machine building (1912)	115,703	.1	1.2	38.0	39.3	1.0	.5	.3	1.8

Examination of the columns giving total frequency rates and total severity rates shows that, on the basis of frequency, the machine-building plants were more hazardous than the steel plant—the respective rates being 39.3 and 38.1 per 1,000,000 hours' exposure. On the basis of severity, however, the steel plant was almost four times as hazardous as machine building—the rates being 7.0 days lost per 1,000 hours' exposure in contrast with 1.8 days.

It is clear that as between these diametrically opposite showings of the relative hazards of the two industries, the severity rates offer a decidedly more accurate measure of true hazard. In machine building there is opportunity for many minor injuries, but the danger of serious injury is much less than in the steel industry. The severity rate brings out this fact.

The second illustration shows how, over a period of years, within the same establishment accident severity rates may run counter to accident frequency rates. Table 2 gives data of this character. It shows the accident experience of a large steel plant over a period of four years. The plant is one in which most serious attention has been devoted to the prevention of accidents.

TABLE 2.—ACCIDENT RATES IN A STEEL PLANT, 1910 TO 1913.

Year.	Number of workers.	Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1910	7,642	0.6	1.4	42.5	44.5	5.1	0.8	0.7	6.6
1911	5,774	.5	1.2	35.5	37.2	4.7	.7	.8	6.2
1912	7,396	.2	2.2	48.8	51.2	2.0	1.8	.9	4.7
1913	7,562	.6	1.5	36.0	38.1	5.5	.7	.8	7.0

Limiting attention to the columns showing total rates, it will be noted that in 1910 the frequency rate was 44.5 per 1,000,000 hours' exposure and the severity rate was 6.6 days per 1,000 hours' exposure. The next year shows a decrease in both frequency and severity. In 1912, however, there was a marked increase in frequency—from 37.2 to 51.2—but the severity rate dropped from 6.2 days to 4.7 days. In other words, accidents had increased considerably in frequency but were decidedly less serious in their average result. In 1913 the experience was reversed. A marked reduction occurred in accident frequency—from 51.2 to 38.1—but the severity rate jumped from 4.7 days to 7.0 days. The year 1913, instead of being a "good year," as it might be assumed to be under the system of frequency rates, was the worst year of the four covered by the table.

These illustrations bring up certain points which it seems desirable to emphasize. The first concerns the use of terms. Severity rates derived in the manner described are expressed for convenience in terms of work days lost. For example, the steel plant referred to above is stated to have had a severity rate in 1913 of 7.0 days per 1,000 hours' exposure. The term "days lost" as thus used is to some extent a statistical abstraction, but it is close enough to concrete fact to permit its use in its ordinary sense without serious error, provided that the weighting scale used is a fairly reasonable one. It is not, however, as absolute amounts of loss that these rates have their most important significance. The relations disclosed between different industrial groups and different periods of time are of greatest moment. The important thing shown by the figures of the steel plant is that hazard increased between 1912 and 1913 in the proportion of 4.7 to 7.0.

This leads to a second point which can not be emphasized too much: The fact that, inasmuch as the real significance of severity rates is in the measurement of relative hazards, the character of the weighting scale used becomes comparatively unimportant. Thus, by changing the weights in the scale given above, the resulting severity rates may be considerably altered in their positive amounts, but unless the changes are of a very radical character the relations between the rates for different groups will remain substantially the same. In other words, it is desirable to have the scale used as accurate as possible, but the fact that a completely accurate scale can not be devised does not impair the value of accident severity rating.

Another fact deserving emphasis is that severity rates have a very important advantage over frequency rates, in that the effect of errors in reporting is minimized. Accident reports are probably never absolutely complete, and, as a rule, the completeness of reporting is in direct proportion to the seriousness of injury. The more serious the injury the greater the likelihood of its being reported. Frequently the reporting of minor injuries is extremely incomplete. Inasmuch as the accuracy of frequency rates depends upon the completeness of accident reports, and as all accidents have the same weight, a failure to report any considerable number of minor accidents renders the rates obtained of very little value. Such is not the case with severity rates. Here the disabilities are weighted according to their importance, and a large group of minor disabilities has comparatively little effect upon the derived severity rate. Thus, from the material available concerning the iron and steel industry, it is estimated that the total exclusion of all disabilities of less than two weeks will rarely diminish the total severity rate for that industry as much as 1 per cent, whereas such an exclusion would diminish frequency rates as much as 60 per cent. In the machine-building industry, according to data for that industry collected by the bureau, the corresponding percentages are 7 and 70.

USE OF RATES IN THE STUDY OF ACCIDENT CAUSES.

Frequency and severity rates, as above described, may be applied to the measurement of accident causes. This procedure is logical and, as carried out in detail in a later chapter, produces interesting and very valuable results. Inasmuch, however, as the computation of accident rates according to causes is still somewhat unfamiliar, a brief preliminary description of the method used is desirable.

For any plant, department, occupation, or other industrial group for which the amount of employment and the number of accidents are known, an accident rate may be computed. This total rate may then be apportioned among the various causes responsible for the accidents. For example, in a group of blast furnaces, with a total frequency rate of 67 per 1,000,000 hours' exposure, 19 cases of each 67 were due to molten metal and 9 to handling tools and objects, leaving 39 assignable to miscellaneous causes. The frequency rate for molten metal in these furnaces was, therefore, 19 per 1,000,000 hours' exposure and that for handling tools and objects was 9.

The value of such rates to the safety man is clearly evident. They indicate, in the example given, that molten metal was the most important single cause of accident in blast furnaces, and the one to which especial attention must be directed.

In the case just cited, the department was taken as the unit, the rates being based on the total employment for the department. If a smaller unit, such as the occupation, be used as a basis, the rates would be based on the amount of exposure in the individual occupation. In the case of the above group of blast furnaces it was possible to isolate certain important occupations, to compute accident rates for each, and to apportion such rates among the different causes. Thus it was found that while the frequency rate for the blast-furnace department as a whole was 67 per 1,000,000 hours' exposure, the rate for "cast-house men" was 127. When this rate was analyzed according to causes it was found that molten metal contributed 67, falling objects 14, and miscellaneous causes 46.

These cause rates, whether based on the department, the occupation, or any other group, are true accident rates, analogous to the death rates by disease as used in mortality studies. In such studies it is customary to divide the general death rate for a community into specific rates for the various diseases causing death. Thus a general death rate of 20 per 1,000 for a given city may be made up of the following specific rates—tuberculosis 5, typhoid fever 2, other causes 13. These rates, it may be noted, measure the real prevalence of the several diseases in a way that percentages can not do. Thus, in the year noted, deaths from tuberculosis constituted 25 per cent of all deaths (5 out of 20). Suppose that in the following year a typhoid epidemic increased the typhoid rate from 2 to 7 and thus caused the general rate to jump from 20 to 25, the tuberculosis death rate of 5 per 1,000 would remain as before, but expressed in percentages tuberculosis would have decreased from 25 per cent (5 out of 20) to 20 per cent (5 out of 25) as a cause of death. The percentage change would suggest a great decrease in the tuberculosis hazard, which, however, as the rate accurately indicates (5 per 1,000), remained absolutely stationary. The attempt to study causes of death by means of percentage figures is thus liable to be entirely misleading. Rates, on the other hand, offer an absolutely reliable measure. This is equally true, and for the same reasons, in the study of accident causes.

The above illustrations of the use of cause rates were limited, for the sake of simplicity, to frequency rates. Severity rates can, of course, be applied in precisely the same way and with even more valuable results, inasmuch as severity rates, as pointed out above, are a truer measure of accident hazard than are frequency rates.

USE OF RATES IN THE STUDY OF OTHER FACTORS.

The usefulness of rates, both frequency and severity, extends to the nature of injury, results of injury, and other similar items. To illustrate: In a group of blast furnaces with a frequency rate of 63 per 1,000,000 hours' exposure it was found on analysis that 30 cases out of each 63 were bruises and lacerations, 15 were burns, 3 were fractures, and 15 were miscellaneous injuries. It is entirely proper to say that in these blast furnaces bruises and lacerations had a frequency rate of 30, burns 15, fractures 3, and other injuries 15.

These are true rates and express the facts regarding the different sorts of injury with a precision and clearness which can not be obtained without resort to the rate method.

RATES IN COLLATERAL FIELDS.

There is one field of study which has recently attracted much attention which is related to the accident field in a particularly intimate way. This is the field of "labor mobility." As will appear in a later chapter of this report, the introduction of new men has a close relation to the curve of accident occurrence. This "labor accession" is one phase of the larger problem of "labor mobility."

The same reasons which make it necessary to adopt some standard basal unit in accident study have equal force as applied to the various rates, such as "accession," "separation," etc., which serve to express the facts of mobility. Since a slightly different viewpoint is taken by the student of mobility it will be natural to designate the basic figures as "labor hours" rather than "hours of exposure." This is an advantage rather than otherwise if it be clearly understood that the expressions designate the same thing in different aspects.

The Bureau of Labor Statistics has recognized the desirability of a uniform base in the statistical study of industrial phenomena by adopting "labor hours" in the computation of the rates used in a survey of "labor mobility."[55]

The value of placing all these discussions on a common basis is that whenever a considerable body of information is obtained it becomes at once possible, with no change in the figures, except perhaps an adjustment of the decimal point, to place the rates in comparison and ascertain any possible correlations. To illustrate, on page 170 will be found a chart which presents in graphic form the fluctuations of employment, of labor accession, of accident occurrence, and of product over a series of years. The fact that all these are related to the number of hours of exposure makes possible direct comparison of any two items, such as labor accession and accident occurrence. It will be found that there is a remarkably constant correspondence between the curves representing these two items. If accident study were undertaken in connection with plants in which labor mobility had been studied, it would be of the greatest convenience to be able to make similar comparisons without the necessity of making changes and adjustments.

This convenience extends to a great many subjects of industrial concern which will be subjected to statistical scrutiny in the near future. For example, there is some reason to suspect that during the epidemic of influenza in 1918 the condition of the workers was influenced in such a way that there was a marked rise in the accident rate. This possible relation of illness to accident occurrence is of sufficient importance to deserve careful study. Without the use of some common standard in preparing the statistics of illness and of accident satisfactory comparison can not be made.

It is of course true that a radical departure from an accustomed form of presentation, such as this proposed by the committee on statistics of the International Association of Industrial Boards and Commissions, will for some time cause more or less confusion. As, however, the various advantages of the plan of the committee become evident and the strangeness wears off, it will become clear that the general adoption of the methods suggested will constitute a most important advance in statistical procedure in the field of accident study.

---

[55] "Mobility of labor in American industry," by Paul F. Brissenden and Emil Frankel, in Monthly Labor Review of the U. S. Bureau of Labor Statistics for June, 1920, pp. 36-56.

CHAPTER III.—THE PHYSICAL CAUSES OF ACCIDENT—THE DEPARTMENTS COMPARED.

Repeated emphasis may properly be given to the idea that the important purpose of the statistical study of accidents is the determination of means and methods of accident prevention. The mere fact that a given department or industry has a high accident rate may stimulate the safety engineer to harder work but can do nothing to aid him in the determination of the point and method of attack. For purposes of accident prevention the high rate must be traced back to its causes and so a clear idea obtained regarding why and how accidents occur.

To this end this and the two following chapters are devoted to an examination of the physical causes of accidents and an endeavor to suggest such remedies as the facts discovered may indicate. A later chapter is devoted to the consideration of the human factors in the situation.

In all these studies the facts are presented by means of rates. The method of preparing such rates has been discussed in the preceding chapter. While frequency rates are constantly introduced, the main discussion is based on the severity rates. This is done for two reasons: (1) It has been found that the effort to present the facts from both frequency and severity standpoints at the same time leads to some confusion; (2) It is clear that the severity rate is a much more accurate measure of hazard than is the frequency rate and it directs safety effort much more precisely to the point where it is most needed.

The cause rates used in the following chapter are true rates similar to those constantly employed in mortality studies where the rate for a given locality is divided into specific rates for tuberculosis, influenza, and so on. For example, in Table 3 a rate of 1.19 days in blast furnaces for swinging crane loads means that in that department the injuries suffered on account of the workers being struck by swinging loads were equivalent to the loss of 1.19 days per 10,000 hours' exposure.

MACHINERY AS A CAUSE OF ACCIDENT.

Table 3 gives in detail the severity of accidents due to machinery which occurred in each of the departments during the five-year period 1915 to 1919. Table 2 in the appendix gives the number of cases on which these rates are based.

TABLE 3.—MACHINERY AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE)[a] FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSE.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Prime movers and power transmission:													
Steam engines	0.25	0.07		(1)	0.24	0.01		0.04		0.02	0.05		0.01
Internal combustion engines	.14									(1)			(1)
Dynamos and motors				(1)						3.22			.01
Shafts	.01	.01			.49								.26
Set screws, keys, and bolts													(1)
Belts and pulleys												0.04	.27
Working machines:													
Bending rolls									0.21				
Bolt and nut machines									.01		(1)		(1)
Boring mill									(1)		.01		.01
Charging cars			3.02							4.77	(1)		.01
Charging cranes					.01	.03	(1)						
Doublers								.06					
Drill presses	.08		(1)	0.01					1.89	.07	.07		.03
Drills, portable, electric				.02						(1)			(1)
Drills, portable, pneumatic			.01		.04					(1)	(1)		(1)
Forging hammers	.01		(1)				0.09		.10		.43	.10	.14
Grinding wheels	.01	.01	.02	.36	.33	(1)		(1)	.29	5.03	.98	(1)	.08
Hot and cooling beds					.10	.07							.37
Lathes, general	.01	(1)		.02	(1)	(1)	1.78		.12	.02	.39	(1)	.13
Lathes, turret				(1)									
Lathes, wood									(1)		.10		
Millers									.09	.60	(1)		(1)
Mud gun	.20												
Planers, metal	.06								.10		.03		(1)
Planers, wood									.03		.33		(1)
Presses, punch				(1)	.01		.18		1.57		.06		.25
Presses, stamping				(1)							(1)		.04
Pushers						.01	.05						
Reamers	(1)						.02		.29		.01		(1)
Riveters	(1)						(1)		.19		.01		.01
Rolls			.97		1.55	.03		.21	.02		(1)		.22
Roll tables					2.72	.54					.02		.39
Saws, band									(1)		.01		(1)
Saws, crosscut	.01			.01					(1)	.01	.01	.01	.02
Saws, metal					.78	(1)	1.78		(1)	.02	.04	.61	.36
Saws, rip	.57			(1)	.07				.11		.32		.01
Shapers			(1)		(1)				.01	(1)	.02		

[1] Less than 0.005.

[a] In this chapter 10,000,000 hours' exposure is used as a base for frequency and 10,000 hours' exposure for severity. This is done in order to avoid extended decimals.

TABLE 3.—MACHINERY AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSE—Concluded.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Working machines—Concluded.													
Shears		0.03	0.11	0.01	0.27	1.02	0.02	2.62	0.38	0.02	0.14	0.15	0.46
Slotters											.01		
Straighteners			[1]		.05								
Tappers							.04						
Threaders	[1]						.48				[1]		
Transfer tables						.05							
Tube drawing benches							.02						
Forging presses													.09
Other machinery:													
Elevator accidents	1.14	.02	.02		[1]				[1]	.05		.01	.01
Crane, caught by chain or hook	.17	1.04	1.01	1.23	.54	.46	.25	.18	1.27	.04	.64	.34	.56
Crane, cable catching person	[1]	.18	.15	.03	.08	[1]					[1]		[1]
Crane, load swinging	1.19	3.92	2.96	1.29	.21	3.22	.07	.04	.37	.02	.13	1.61	.59
Crane, load lowering	1.20	.20	1.13	1.33	.53	.21	.03	.04	1.37	[1]	.08	.12	.48
Crane, load falling	1.14	.02	3.25	2.43	.15	6.60	3.67	.17	2.58	.06	1.82	2.11	1.43
Crane, load falling, broken machinery			[1]		.01	[1]					.02	.02	[1]
Crane, load falling, hitch slipped	1.14		.01	.03	.02				.05		.02	.02	.01
Crane, objects falling from crane	[1]		.05	.02	.04	.01	[1]		.04	.03	.05	[1]	.04
Crane, falls from crane or truck		.05	1.99	.01	.62		.03		1.83	9.62	.81		[1]
Crane, other accidents	3.50	7.51	2.57	6.13	1.43	.22	2.49	[1]	4.94	5.84	2.43	.15	1.24
Derricks and hoists	1.14				[1]					1.59			[1]
Blocks and tackles, windlasses, etc	1.15		[1]	.03	[1]	.16					.02		.02
Conveyors	[1]		[1]	.01	.03	.01					.81		.36
Gantry cranes	.03								[1]		.81		[1]
Locomotive cranes	.04		.98	.01	[1]	[1]							1.08
Pumps	.06		[1]		.01				.23		.02		.02
Fans and blowers									.02				
Unclassified	1.28	3.68	1.00	.06	.32	.03	1.22	.18	.41	.34	.51	8.27	2.52
Total	14.52	16.74	19.25	13.05	10.71	12.68	12.29	3.54	18.54	31.38	11.16	13.57	11.59

[1] Less than 0.005.

The most cursory inspection of Table 3 shows emphatically that the crane in its various forms and conditions of action is the most hazardous of machines. So much so is this true that cranes have commonly been considered in a class by themselves. The present arrangement, suggested by the committee on statistics of the International Association of Industrial Accident Boards and Commissions, has the advantage both of being essentially logical and of bringing out clearly the fact that while what are termed "working machines" do not have a very high hazard, "machinery" considered as a whole does contribute materially to the danger of this industry.

The importance of cranes as accident causes may be illustrated by the following statement. In the following departments, out of the total severity rate for machinery the stated portion is due to cranes and hoisting apparatus: In blast furnaces, 10.70 out of 14.52 days per 10,000 hours' exposure; in open hearths, 14.10 out of 19.25 days; in foundries, 12.55 out of 13.05 days; in fabrication, 12.45 out of 18.55 days.

On further study of the table it develops that miscellaneous accidents which can not be more precisely located than that they were due to crane operation are responsible for a larger part of the loss due to crane accidents than either of the other classifications of such accidents. Next to these miscellaneous accidents come those which can be assigned to the falling of the loads. The main cause of such occurrence is some unsuspected weakness of the chains used. This serves to bring to notice again the continuing need of the greatest care in selecting and caring for hoisting chains. Since in 9 out of 13 groups this preponderance of the crane as a cause of injury is evident, it becomes quite clear that the safety engineer still has a serious problem to contend with in controlling crane accidents.

A few of the points worthy of notice as to the rates for the individual departments are the following: In open hearths a considerable part of the severity rate is due to the charging car (3.02 out of 19.25 days); in heavy rolling mills it is quite natural that the rolls and the roll tables contribute rather notably to the severity rate (4.27 out of 10.71 days); in tube mills the metal saw is outstanding (1.78 out of 12.29 days); in sheet rolling the shears are sufficiently prominent to attract attention (2.62 out of 3.54 days).

Table 4 and Chart 1 summarize conditions as to accidents due to machinery.

Table 4.—MACHINERY AS A CAUSE OF ACCIDENT: NUMBER OF CASES AND ACCIDENT FREQUENCY AND SEVERITY RATES, 1915 TO 1919, BY DEPARTMENTS.

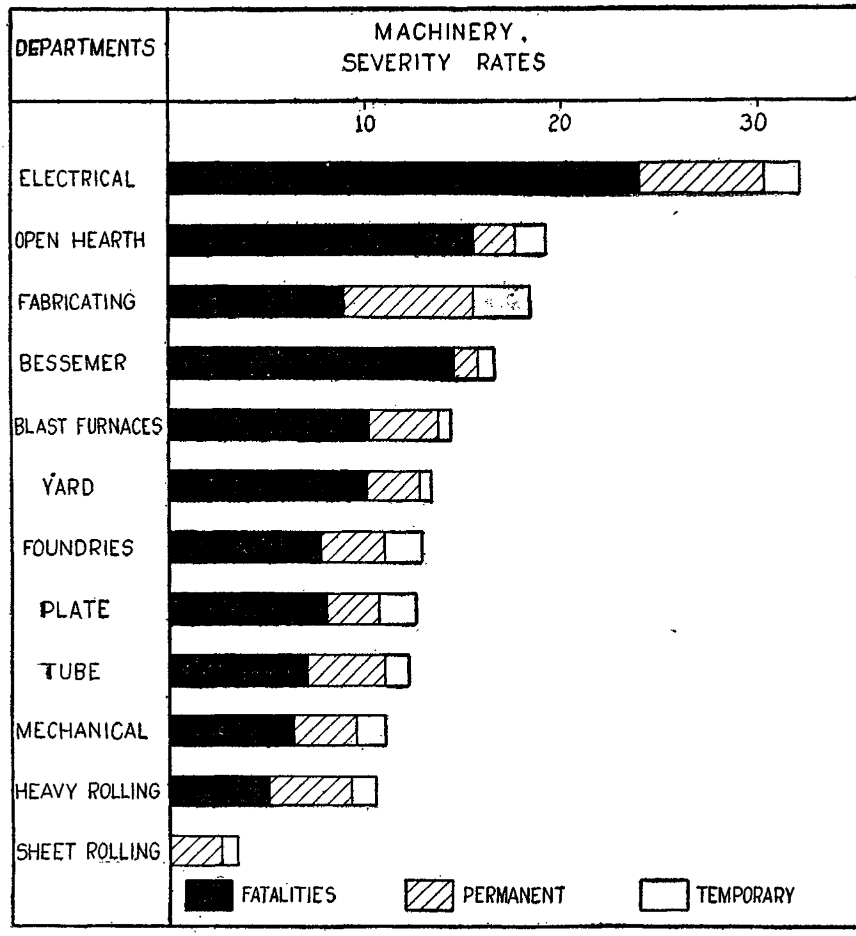
Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Electrical	4,191	5	6	65	76	4.0	4.8	51.7	60.5	23.86	6.44	1.08	31.38
Open hearths	20,525	16	22	365	403	2.6	3.6	59.3	65.5	15.59	2.12	1.54	19.25
Fabricating	11,110	5	40	484	529	1.5	12.0	145.2	158.7	9.00	6.74	2.81	18.55
Bessemer	5,450	4	4	46	54	2.4	2.4	28.1	33.0	14.68	1.28	.78	16.74
Blast furnaces	17,621	9	19	125	153	1.7	3.6	23.6	28.9	10.22	3.72	.58	14.52
Yards	9,819	5	9	87	101	1.7	3.1	29.5	34.3	10.18	2.78	.60	13.57
Foundries	10,222	4	12	308	324	1.3	3.9	100.4	105.6	7.83	3.18	2.04	13.05
Plate mills	14,711	6	19	347	372	1.4	4.3	78.6	84.3	8.16	2.65	1.87	12.68
Tube mills	11,621	4	17	98	119	1.2	5.0	29.0	35.2	7.10	3.99	1.20	12.29
Mechanical	24,752	8	33	597	638	1.1	4.4	80.4	85.9	6.46	3.17	1.53	11.16
Heavy rolling mills	27,123	7	42	403	452	.9	5.1	49.5	55.5	5.16	4.32	1.23	10.71
Sheet rolling mills	5,920	......	8	65	73	......	4.5	36.6	41.1	......	2.70	.84	3.54
Miscellaneous	55,534	18	68	1,125	1,211	1.1	4.1	67.5	72.7	6.48	3.64	1.47	11.59

This table presents the number of cases, the frequency rates, and the severity rates for 13 departmental groups. The first point to be considered is that frequency and severity vary independently of each other. It was this fact, that industries which had a large number of cases would often have but a small proportion of serious injury, which led to the development of the severity rate, into which all forms of accident enter with a weight somewhat commensurable with their importance.

The departments are arranged in the order of severity. It is thought that this will make the charts more readily understood than to adopt a fixed order for all the charts as was done in Bulletin No. 234.

It is a distinct surprise to find the electrical department at the top of this list. It was well known that the electrical workers were subject to a high hazard, but that this should appear in connection with machinery was not expected. An examination of the detail table shows that of the total rate of 31.38 days, 3.22 is from dynamos and motors, 4.77 from open-hearth charging cars, 17.20 from cranes, and 6.19 from other causes. Evidently their duties in the adjustment and repair of these machines subject these workers to serious hazard. It is probable that during the past few years such work has been done under stress in the matter of time and working conditions, which has accentuated the natural dangers of their occupation. Since 9.62 days of this severity rate are due to falls from the crane it may be suggested that not all cranes have yet been reconstructed along modern lines in the matter of walks and railings for the security of the man who must go upon them to do his work. These hazards are evidently such as may be expected in the regular routine of an electrical worker's duties unless adequate protection is provided against them. The rate of 5.03 days for accidents due to grinding wheels is probably exceptional, since these workers are certainly not exposed to this hazard to a degree greater than other workers.

CHART 1.—MACHINERY AS A CAUSE OF ACCIDENT.



PARTS OF MACHINE.

Some additional light is shed upon machine hazard when the severity of accidents due to different parts of the machine is considered. It appears that on the whole it is the point of operation which continues to be the danger point. Flywheels, set screws, and counterweights have almost ceased to be important.

TABLE 5.—MACHINERY AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY PART OF MACHINE CAUSING ACCIDENT.

Part of machine.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Working machines:							
Point of operation	0.73	0.03	0.12	0.36	0.83	0.86	1.01
Belts	.02		.98	.03	.01		.09
Cranks and eccentrics	(1)	(1)			.03	.01	
Fly wheels	(1)						
Gears	.40		.02	.02	2.17	.48	.18
Set screws							
Counterweights							
Other parts	2.57	.30	.25	.14	1.41	.22	3.68
Unclassified	1.14				.01	.14	

Part of machine.	Sheet rolling mills.	Fabricating.	Mechanical.	Yards.	Miscellaneous.	Total.
Working machines:						
Point of operation	2.81	5.04	2.23	0.24	1.35	15.61
Belts		.02	.02		.31	1.48
Cranks and eccentrics			.01		.02	.07
Fly wheels						(1)
Gears	.02	.09	.14		1.51	5.03
Set screws			(1)			(1)
Counterweights		(1)	(1)		(1)	(1)
Other parts	.05	.46	.35	.12	.85	10.40
Unclassified					.02	1.31

[1] Less than 0.005.

Table 6 supplements Table 5 as regards the point of operation being the danger point. This shows that the accidents occur largely in adjusting the machine or work and in the actual operation. Cleaning and oiling comes next in order. In the heavy rolling mills this process is responsible for the highest rate (2.27 days). This is undoubtedly related in part to the necessary attention to gears which the preceding table shows to have a serious severity rate (2.17 days) in heavy rolling mills.

TABLE 6.—MACHINERY AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY OPERATION OR CONDITION.

Operation or condition.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Working machines:							
Adjusting	0.20	3.68	0.99	0.06	0.99	0.08	0.23
Operating	3.00	.23	.26	.43	1.10	1.50	3.04
Cleaning and oiling	.27	.07		.01	2.27	.01	.09
Repairing	.02				.45		.02
Breakage			.01	.02	.16	(1)	.03
Objects flying	.01	.04	.01	.08	.79	.05	1.81
Other conditions	.34	(1)	.13		.41	.12	
Unclassified	1.14			(1)	.01	(1)	

Operation or condition.	Sheet rolling mills.	Fabricating.	Mechanical.	Yards.	Miscellaneous.	Total.
Working machines:						
Adjusting	1.79	0.59	0.25	0.02	0.64	0.63
Operating	.98	3.71	2.43	.24	2.45	1.85
Cleaning and oiling	.02	.09	.03		.54	.47
Repairing		(1)	.02		(1)	.06
Breakage		.02	.01		.73	.21
Objects flying	.03	1.24	.48	.68	.29	.43
Other conditions	.06	.02	.03	.05	.03	.12
Unclassified					.02	.10

[1] Less than 0.005.

POWER VEHICLES AS A CAUSE OF ACCIDENT.

Table 7 presents the details for the departments regarding power vehicles. The available material, though covering the 5-year period 1915 to 1919, is somewhat scanty for as extended an analysis as that here attempted. The results should therefore be taken as suggestive rather than typical.

TABLE 7.—POWER VEHICLES AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Steam and electric railways:							
Train wrecks, collision	1.14						
Train wrecks, derailment			0.01				
Falls, getting on or off, in motion	.01		.01		(1)		
Falls, getting on or off, at rest	.04	0.01	.08	0.01	0.03	(1)	(1)
Falls, riding on, sudden start or stop	2.27		.04		.74		
Falls, riding on, slipping or lost balance	.48		.97				0.05
Falls, riding on, overhead structure	(1)		.01				
Falls, riding on, side structure	(1)		.02				
Falls, not otherwise classified	(1)		.02				
Struck by or caught between cars	7.70	11.50	5.75	(1)	2.89	0.01	.55
Struck by when coupling or uncoupling	2.29	1.58	1.55	.01	.59	(1)	
Struck when switching	.02	.01	.01		(1)		
Struck when repairing track							
Struck when crossing track			.02		(1)		
Struck when standing or walking on track			.01		.07		
Setting or releasing hand brakes	(1)			.01			
Objects falling from	.17	.06	1.06	.04	.77	.01	
Other accidents	4.74	.26	2.05		(1)	.02	.18
Auto vehicles:							
Collisions with other vehicles	(1)						
Cranking				(1)			
Struck by		(1)		.01	.74	(1)	.01
Objects falling from			(1)				
All other	.01	.07				.02	
Unclassified	.08	.02	.17	.03	.04	(1)	.01
Not reported							
Total	18.96	13.50	11.77	.12	5.92	.07	.80

Accident cause.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Steam and electric railways:						
Train wrecks, collision					2.08	(1)
Train wrecks, derailment					.04	(1)
Falls, getting on or off, in motion		0.03		(1)	1.84	0.37
Falls, getting on or off, at rest		.02	(1)	0.02	.19	.03
Falls, riding on, sudden start or stop				.01	.85	(1)
Falls, riding on, slipping or lost balance		.02			2.08	.15
Falls, riding on, overhead structure						
Falls, riding on, side structure					.01	
Falls, not otherwise classified		(1)		.01	.01	.01
Struck by or caught between cars			0.02	.40	25.06	3.39
Struck by when coupling or uncoupling		.01	.05	.01	13.00	.26
Struck when switching		.01	.02	(1)	1.00	.01
Struck when repairing track					1.53	
Struck when crossing track					2.15	.24
Struck when standing or walking on track					.01	
Setting or releasing hand brakes					.08	
Objects falling from	0.01	(1)	(1)	.01	.12	.40
Other accidents			.02	.87	4.01	.43
Auto vehicles:						
Collisions with other vehicles				.54		(1)
Cranking		(1)		.02		.02
Struck by				.04		(1)
Objects falling from						
All other						(1)
Unclassified		(1)	.04	.83	.27	1.11
Not reported						
Total	.01	.10	.16	2.76	54.35	6.44

1 Less than 0.005.

As would be expected, the yards greatly exceed any other department in the severity of the accidents due to power vehicles. The rate (54.35 days per 10,000 hours' exposure) is nearly double that of the electrical department in relation to machinery (31.38 days). Of this total rate a very striking portion (25.06 days) is assignable to being struck by or caught between cars. It is not possible to determine how much of this is due to the fault of the men, but it may be urged that fault in the arrangement of the transportation facilities is distressingly common and that it is too often necessary for the worker to subject himself to danger which could be avoided by a better arrangement. The rate of 13.00 days for coupling accidents is an interesting commentary upon the fact that in intraplant transportation the automatic coupler has not yet come into its own. When it has been introduced more thoroughly such a rate will no longer be possible.

It should be noted that while these yard accidents overtop all other kinds of accidents in their severity they are nowhere near the rates of those who are occupied solely in transportation. The severity rate for death of yard employees is 40.74 days per 10,000 hours exposed. In 1918, the latest year for which information is at this time obtainable the switchmen in railway yards in the United States numbered 53,790. Among them there were 397 fatalities. This means when translated into terms of the severity rate as used in this report a rate of 147.61 days per 10,000 hours exposed. This is exceeded by no department of the iron and steel industry except erection of structural steel, which for the five years ending in 1919 had a rate of 181.00 days.

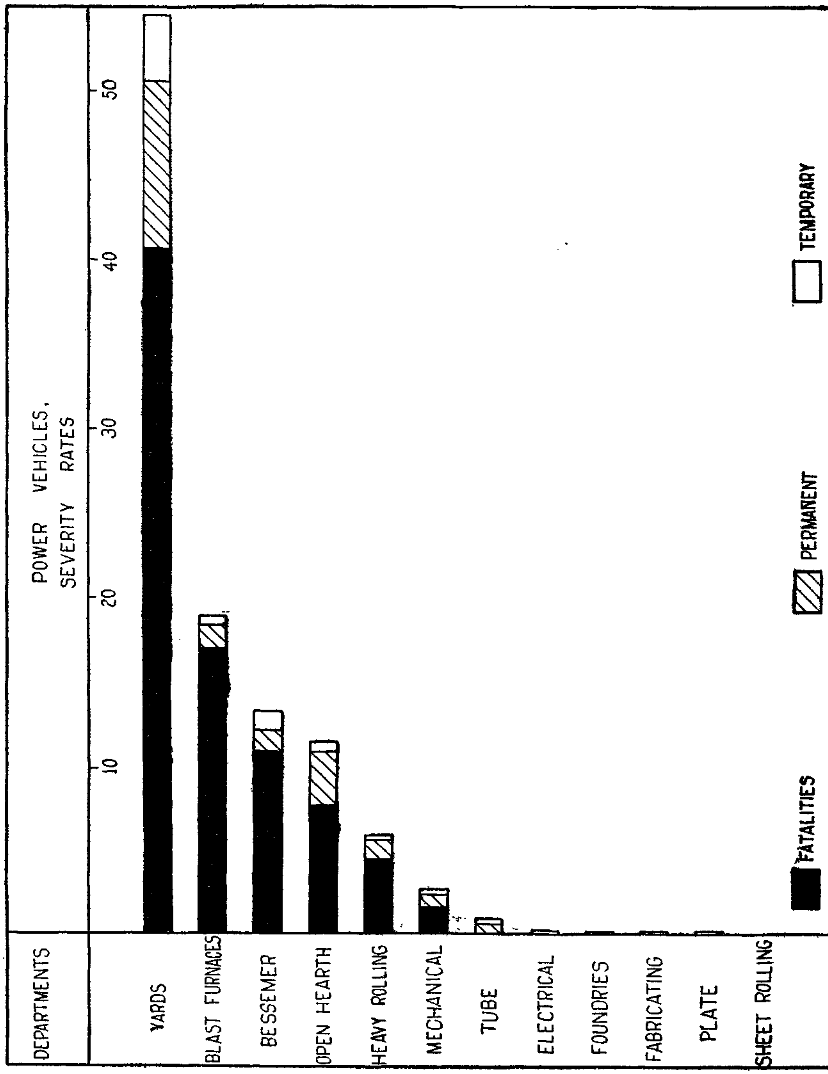
The blast furnaces (18.96 days), Bessemer (13.50 days), and open hearths (11.77 days) are the other departments having notable rates. This is due, of course, to the fact that in them large quantities of raw material are constantly being moved.

Table 8 and Chart 2 summarize the facts regarding power vehicles.

TABLE 8.—POWER VEHICLES AS A CAUSE OF ACCIDENT: NUMBER OF CASES AND ACCIDENT FREQUENCY AND SEVERITY RATES, BY DEPARTMENTS, 1915 TO 1919.

Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Yards	9,819	20	24	443	487	6.8	8.1	150.4	165.3	40.74	9.86	3.75	54.35
Blast furnaces	17,621	15	3	131	149	2.8	.6	24.8	28.2	17.03	1.45	.48	18.96
Bessemer	5,450	3	5	41	49	1.8	3.1	25.1	30.0	11.00	1.28	1.22	13.50
Open hearths	20,525	8	16	178	202	1.3	2.6	28.9	32.8	7.80	3.21	.76	11.77
Heavy rolling mills	27,123	6	7	48	61	.7	.9	5.9	7.5	4.42	1.22	.28	5.92
Mechanical	24,752	2	2	48	52	.3	.3	6.5	7.1	1.62	.86	.28	2.76
Tube mills	11,621	......	2	7	9	......	.6	2.1	2.7	......	.62	.18	.80
Electrical	4,191	......	......	7	7	......	......	5.6	5.6	......	......	.16	.16
Foundries	10,222	......	......	21	21	......	......	6.8	6.8	......	......	.12	.12
Fabricating	11,110	......	......	13	13	......	......	3.9	3.9	......	......	.10	.10
Plate mills	14,711	......	......	20	20	......	......	4.5	4.5	......	......	.07	.07
Sheet rolling mills	5,920	......	......	......	......	......	......	......	......	......	......	......	......
Miscellaneous	55,534	14	7	192	213	.8	.4	11.5	12.7	5.04	1.17	.23	6.44

CHART 2.—POWER VEHICLES AS A CAUSE OF ACCIDENT.



HOT SUBSTANCES AS A CAUSE OF ACCIDENT.

Table 9 contains the details for the departments as regards hot substances as causes of accidents. It covers the characteristic hazards of the industry.

TABLE 9.—HOT SUBSTANCES AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Explosives:							
Transportation and handling	0.23						
Blasting	(1)						
Dust			0.02				
Gas			.01				
Other	(1)					(1)	(1)
Electricity:							
Short circuits at switches	1.15		.02	0.01	0.02	0.03	0.01
Contact exposed conductors	.02		.01	(1)	.01	.01	(1)
Other	.02		.01	(1)	.01	.01	
Conflagrations	(1)					(1)	
Hot substances and flames, asphalt, etc.:							
Liquids, water	1.19	(1)	.10	.01	.76	1.38	.01
Other liquids			(1)		(1)		
Metal, falls on sheets						(1)	
Handling sheets							
Hot bars in rolls			(1)		.07	.01	.04
Hot scale		0.02	(1)	(1)	.03	.02	.01
Hot stock ejected	(1)						
Molten metal, breakouts	3.41		1.06				
Explosions	2.50	.13	3.09	4.05	.03	(1)	.18
Ingot explosions		7.83	.38	.03			
Sparks and splashes	2.13	8.40	5.03	.47	.74	1.41	.05
Spills	(1)		1.96				
Slag and other	1.66		1.12	.15	(1)	.01	.01
Steam	.10	.07	.05	.02	2.23	.03	(1)
Flames	1.30	3.70	3.15	.07	.78	.02	.02
All other	3.65	3.86	.60	2.16	.95	.15	1.82
Corrosive substances	.02		(1)	(1)	(1)	(1)	.01
Unclassified	1.17		.02	.04	.04	.02	.03
Total	18.54	24.03	16.65	7.02	5.70	3.14	2.18

Accident cause.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Explosives:						
Transportation and handling						
Blasting						0.36
Dust						
Gas				(1)		.36
Other				0.81		
Electricity:						
Short circuits at switches	(1)	0.01	0.56	.02	(1)	.03
Contact exposed conductors			.70	.83	0.02	(1)
Other			9.66	.02	(1)	.01
Conflagrations			.01			(1)
Hot substances and flames, asphalt, etc.:						
Liquids, water			.04	.07	.02	.41
Other liquids		.01				.02
Metal, falls on sheets	0.14					.01
Handling sheets	.03					(1)
Hot bars in rolls		(1)				.11
Hot scale	(1)	.03		.01	.03	.07
Hot stock ejected					(1)	
Molten metal, breakouts						.01
Explosions			.01	.01	(1)	.03
Ingot explosions						
Sparks and splashes	.01	.02	4.81	.85	.11	.06
Spills			(1)			(1)
Slag and other					.02	.37
Steam	(1)	(1)		.02	.02	.39
Flames	.01	1.81	.05	.06	.01	.42
All other	.06	.07	.07	.06	.05	.87
Corrosive substances		(1)		.02		.24
Unclassified	.02	(1)	.08	.02	.01	.16
Total	.28	1.95	24.98	2.79	.27	3.94

[1] Less than 0.005.

In Bulletin No. 234 cranes and hoists slightly exceeded this group in severity. In the present tabulation such is not the case. The changed relation is not marked and has no particular significance.

The fact that the electrical department in this group, as in machinery, is at the head of the list, is probably not a typical situation. When details are considered it appears that the electricians suffered injuries having a rate of 10.93 days per 10,000 hours' exposure out of a total rate of 24.98 days through electrical injury, mostly burns. This represents a condition which very likely is somewhat unusual, but serves to emphasize the importance of greater care in the adjustment of electrical apparatus. A fruitful source of injury is the supposed necessity of adjustment when the current is on. The larger share of the severity rate shown above relates to conditions arising from such procedure.

Each of the four departments in which molten metal is a factor naturally shows rates in that connection of some size; for example, blast furnaces, 9.70 out of 18.54 days; Bessemer, 16.36 out of 24.03 days; open hearths, 12.64 out of 16.65 days.

A rate of 7.83 days for ingot explosions in the Bessemer seems rather inexcusable in view of the possibilities of both screens and safeguards and of modifying the metal itself.

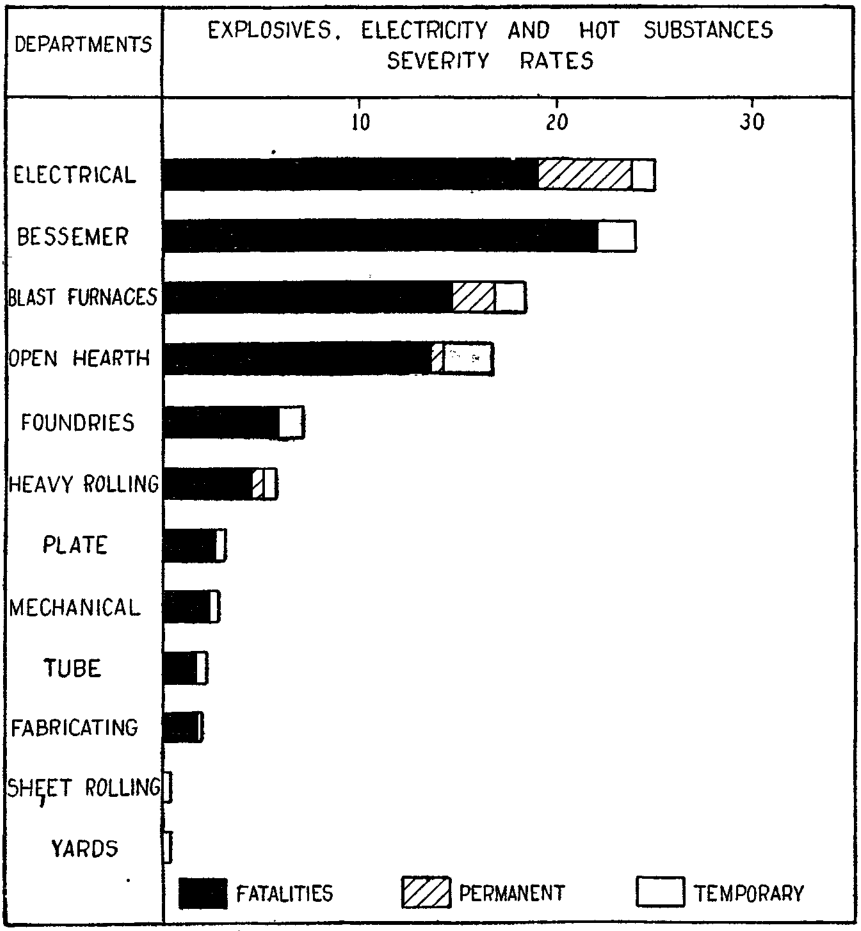
The rate of 4.81 days for electricians in connection with splashes of metal is evidence that the duties of these men often demand that they work in conditions where they are menaced both by the hazard which always lurks in the electric current and by dangers belonging to the department in which they are obliged to work.

Summary Table 10 and Chart 3 follow.

TABLE 10.—HOT SUBSTANCES AS A CAUSE OF ACCIDENT: NUMBER OF CASES AND ACCIDENT FREQUENCY AND SEVERITY RATES, 1915 TO 1919, BY DEPARTMENTS.

Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Electrical	4,191	4	1	119	124	3.2	0.8	94.7	98.7	19.09	4.77	1.12	24.98
Bessemer	5,450	6	.....	114	120	3.7	.....	69.7	73.4	22.02	.....	2.01	24.03
Blast furnaces	17,621	13	5	418	436	2.5	.9	79.1	82.5	14.76	2.21	1.57	18.54
Open hearths	20,525	14	3	764	781	2.3	.5	124.1	126.9	13.64	.66	2.35	16.65
Foundries	10,222	3	.....	167	170	1.0	.....	54.5	55.5	5.87	.....	1.15	7.02
Heavy rolling mills	27,123	6	3	236	245	.7	.4	29.0	30.1	4.42	.66	.62	5.70
Plate mills	14,711	2	.....	160	162	.5	.....	36.3	36.8	2.72	.....	.42	3.14
Mechanical	24,752	3	.....	181	184	.4	.....	24.4	24.8	2.42	.....	.37	2.79
Tube mills	11,621	1	.....	53	54	.3	.....	15.7	16.0	1.78	.....	.40	2.18
Fabricating	11,110	1	.....	40	41	.3	.....	12.0	12.3	1.80	.....	.15	1.95
Sheet rolling mills	5,920	....	.....	39	39	....	.....	22.0	22.0	....	.....	.28	.28
Yards	9,819	....	.....	51	51	....	.....	17.3	17.3	....	.....	.27	.27
Miscellaneous	55,534	8	4	632	644	.5	.2	37.9	38.6	2.88	.40	.66	3.94

CHART 3.—HOT SUBSTANCES AS A CAUSE OF ACCIDENT.



FALLS OF WORKER AS A CAUSE OF ACCIDENT.

Table 11 presents in detail the facts regarding the cause group, "falls of worker."

The electrical department and the blast furnaces are the outstanding features of this table. When the details in the electrical experience are considered it becomes evident that falls from poles and roofs are the serious matter (9.77 out of 11.21 days). This is easily understood as being the result of the necessity which the linemen are under of climbing to and working at these elevations. It is extremely probable that some of these cases are to be attributed to the electric current. A shock which would not in itself be seriously harmful might cause a man to loose his hold and fall. Certain forms of protection, such as insulating blankets, by which the live wires near which it may be necessary to work are covered, deserve a much wider use than is now given them.

TABLE 11.—FALLS OF WORKER AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Falls of worker:							
From benches, boxes, chairs, and tables	(1)	0.02	(1)	0.02	0.01	(1)	....
From buildings, in construction or demolition	0.01	....	(1)	(1)	....	....	....
From cranes, derricks, or hoists in erecting or rigging	....	....	....	....	....	....	....
From ladders	.41	.01	0.06	.03	.03	0.02	0.01
From piles	(1)	.02	.01	(1)	.02	.01	.01
From poles and trees	....	....	....	....	....	....	....
From roofs	(1)	....	(1)	....	(1)	....	....
From runways, balconies, and platforms	.03	.17	.17	.01	.01	(1)	....
From scaffolds or staging	1.25	.41	.06	(1)	.01	.02	1.78
From stairs	.05	.28	.01	.02	.03	(1)	....
From tramways and trestles	.36	....	....	....	....	....	....
From other elevations	3.83	.05	.16	1.99	.07	.01	.01
Into bins and vats	1.18	....	.05	(1)	(1)	....	....
Into floor openings	.02	.04	.07	....	.03	.04	.04
Into manholes	.02	....	.02	....	.09	.03	....
Into excavations	.02	.02	.03	.01	.01	(1)	....
Due to slipping on level	.12	.23	.25	.27	.16	.21	.14
Due to stumbling on level	.07	.04	.06	.06	.08	.05	.12
Other falls	.04	.07	.08	.04	.08	.03	.03
Total	7.41	1.36	1.04	2.46	.62	.41	2.13

Accident cause.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Falls of worker:						
From benches, boxes, chairs, and tables	0.01	(1)	0.01	0.01	....	0.01
From buildings, in construction or demolition	....	....	....	.09	....	.01
From cranes, derricks, or hoists in erecting or rigging	....	....	....	....	....	.36
From ladders	....	0.03	.71	.04	(1)	.43
From piles	....	(1)	....	(1)	(1)	.01
From poles and trees	....	....	4.86	....	....	....
From roofs	....	....	4.91	.84	(1)	.38
From runways, balconies, and platforms	.01	....	.14	1.67	0.02	.39
From scaffolds or staging	....	1.93	.06	.15	.02	.01
From stairs	....	.01	.02	.01	.01	.03
From tramways and trestles	....	....	....	....	(1)	....
From other elevations	.02	.07	.23	1.69	.05	.03
Into bins and vats	....	(1)	....	....	....	(1)
Into floor openings	.01	....	.07	.02	.01	.39
Into manholes	.02	....	(1)	(1)	.01	(1)
Into excavations	....	....	....	.01	.04	.03
Due to slipping on level	.23	.15	.10	.17	.08	.58
Due to stumbling on level	.11	.07	.06	.09	.11	.44
Other falls	(1)	.03	.04	.14	.03	.05
Total	.41	2.30	11.21	4.93	.38	3.16

1 Less than 0.005.

The blast furnaces show high rates for the following: Falls from scaffolds and staging (1.25 days); from other elevations (3.83 days); and into bins (1.18 days). A glance at the furnace in Plate 7 will suggest why this is the case. It is not possible to say whether the furnaces covered by this study are all equipped to a reasonable standard with walkways and railings. It is true, however, that there are still many furnaces not standard in this particular and where the risk of falls which may result in death is very serious.

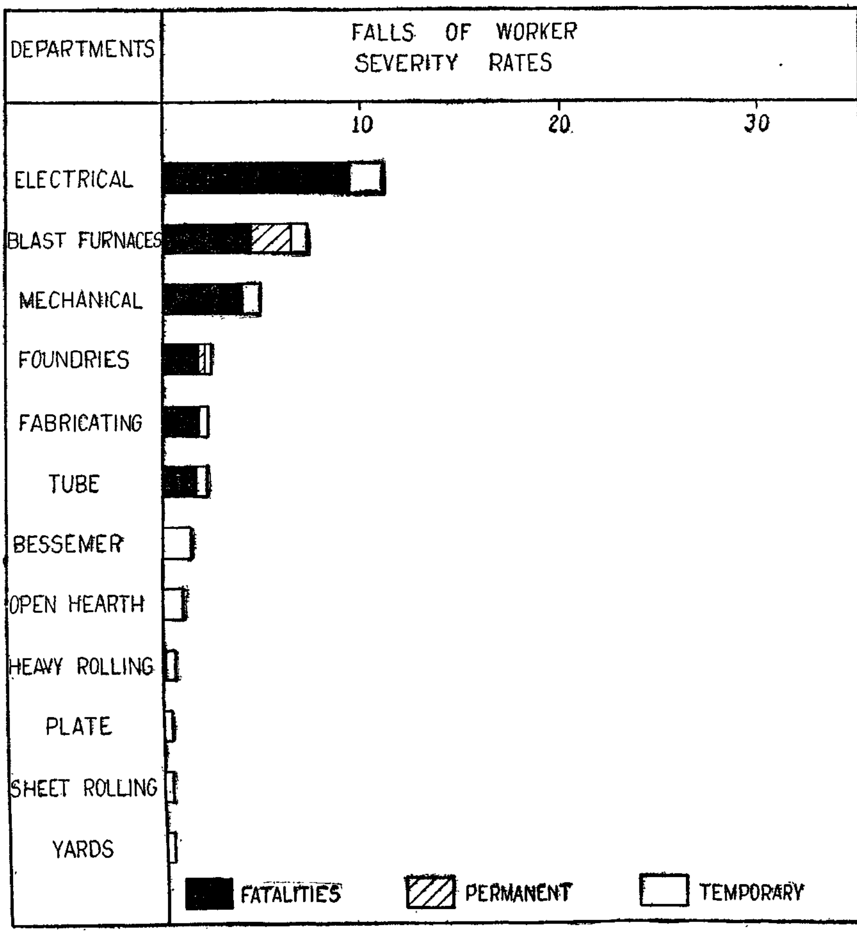
While falls due to slipping and stumbling on the level do not give rise to very conspicuous rates they are very constant throughout all the departments and suggest pointedly that the use of antislip material and the maintenance of clear and tidy passageways should not be neglected.

Table 12 and Chart 4, which follow, give a condensed picture of this group of causes.

TABLE 12.—FALLS OF WORKER AS A CAUSE OF ACCIDENT: NUMBER OF CASES AND ACCIDENT FREQUENCY AND SEVERITY RATES, 1915 TO 1919, BY DEPARTMENTS.

Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Electrical	4,191	2	.....	71	73	1.6	.....	56.5	58.1	9.54	.....	1.67	11.21
Blast furnaces	17,621	4	4	191	199	.8	0.8	36.1	37.7	4.54	2.19	.68	7.41
Mechanical	24,752	5	.....	289	294	.7	.....	38.9	39.6	4.04	.....	.89	4.93
Foundries	10,222	1	1	75	77	.3	.3	24.5	25.1	1.96	.20	.30	2.46
Fabricating	11,110	1	.....	93	94	.3	.....	27.9	28.2	1.80	.....	.50	2.30
Tube mills	11,621	1	.....	37	38	.3	.....	10.9	11.2	1.78	.....	.35	2.13
Bessemer	5,450	....	.....	47	47	....	.....	28.7	28.7	....	.....	1.36	1.36
Open hearths	20,525	....	.....	282	282	....	.....	45.8	45.8	....	.....	1.04	1.04
Heavy rolling mills	27,123	....	1	203	204	....	.1	24.9	25.0	....	.09	.53	.62
Plate mills	14,711	....	.....	120	120	....	.....	27.2	27.2	....	.....	.41	.41
Sheet rolling mills	5,920	....	.....	40	40	....	.....	22.5	22.5	....	.....	.41	.41
Yards	9,819	....	.....	73	73	....	.....	24.8	24.8	....	.....	.38	.38
Miscellaneous	55,534	7	3	537	547	.4	.2	32.2	32.8	2.52	.07	.57	3.16

CHART 4.—FALLS OF WORKER AS A CAUSE OF ACCIDENT.



FALLING OBJECTS AS A CAUSE OF ACCIDENT.

Table 13 presents the details regarding the group, "falling objects."

TABLE 13.—FALLING OBJECTS AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Collapse of scaffolds or staging	(1)	....	0.02	....	....	....	....
Falling objects:							
From buildings	0.06	....	(1)	0.01	(1)	(1)	....
From chutes, conveyors, or slides	.01	....	.01	....	(1)	....	....
From machines or workbenches	(1)	....	.01	.03	0.04	0.06	0.03
From piles	.14	0.30	1.05	.07	.17	.13	.07
From racks and shelves	.01	....	(1)	.01	.01	....	.05
From runways, balconies, etc	(1)	....	(1)	....	(1)	....	....
From scaffolds and staging	.02	....	.01	....	....	(1)	....
From temporary floors	....	....	....	....	....	....	....
From tramways and trestles	(1)	....	....	....	.01	....	(1)
From other elevations	5.02	.50	3.64	.55	.57	1.25	.27
Cave-in of ditches	....	....	....	1.96	....	....	(1)
Objects tipping over (not vehicles)	.12	4.13	3.27	3.11	.54	.41	.34
Other falling objects	.12	3.67	.04	.03	.32	(1)	....
Total	5.50	8.61	8.06	5.80	1.67	1.86	.76

Accident cause.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Collapse of scaffolds or staging	....	....	0.04	0.01	....	(1)
Falling objects:						
From buildings	0.01	(1)	.02	.82	(1)	0.01
From chutes, conveyors, or slides	....	....	....	.01	0.02	(1)
From machines or workbenches	(1)	0.05	(1)	.87	2.06	.76
From piles	.43	.07	.04	.05	.25	.84
From racks and shelves	....	.01	....	.01	....	.01
From runways, balconies, etc	....	....	....	(1)	....	(1)
From scaffolds and staging	....	.01	....	.02	....	.01
From temporary floors	....	....	....	....	....	....
From tramways and trestles	....	....	....	....	....	.01
From other elevations	.26	2.29	.24	.47	.24	1.46
Cave-in of ditches	....	....	....	(1)	....	.01
Objects tipping over (not vehicles)	.18	.66	.19	.25	.37	.97
Other falling objects	(1)	.01	....	.01	(1)	.01
Total	.89	3.10	.53	2.54	2.94	4.09

1 Less than 0.005.

The high rates in this table are found under blast furnaces, for objects falling from miscellaneous elevations (5.02 days per 10,000 hours exposed); under Bessemer, for objects tipping over (4.13 days); under open hearths, for objects falling from miscellaneous elevations (3.64 days) and objects tipping over (3.27 days); and under foundries, for objects tipping over (3.11 days).

In the steel-making departments the handling and storage of ingot molds give rise to accidents from time to time due to their tipping over. It is believed that improvement in regard to this matter is possible.

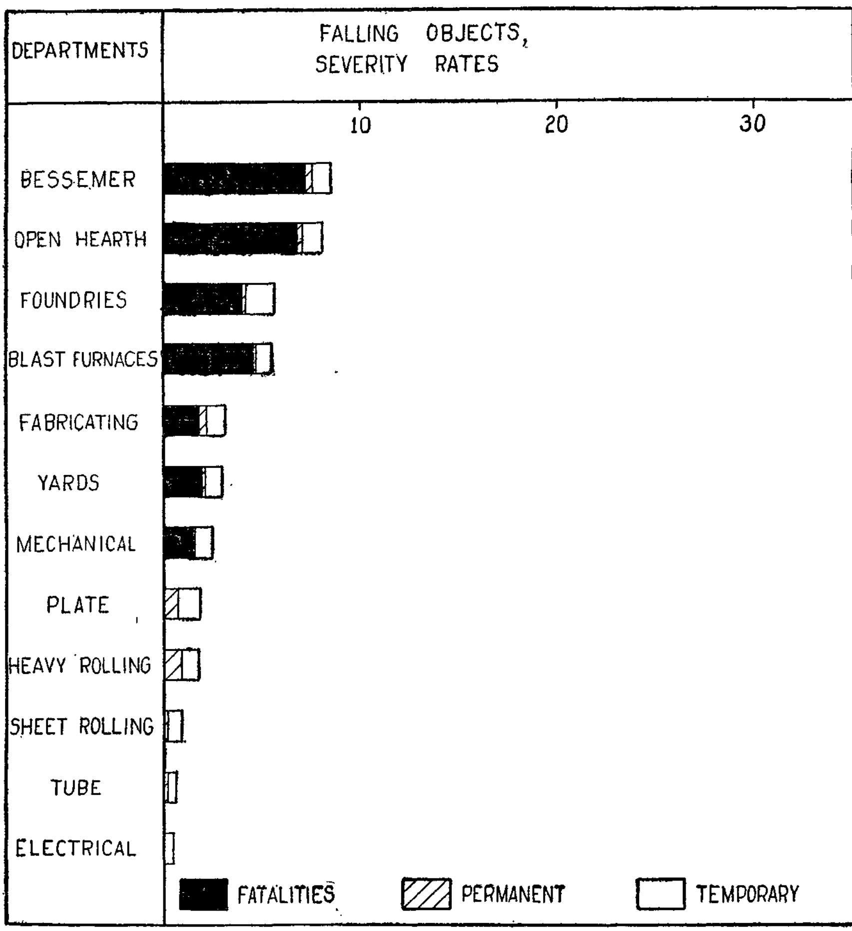
The fact that objects falling from piles are a very constant, though not extremely serious, source of danger suggests that there is still room for improvement in the matter of piling material.

Table 14 and Chart 5 summarize this group of causes.

TABLE 14.—FALLING OBJECTS AS A CAUSE OF ACCIDENT: NUMBER OF CASES AND ACCIDENT FREQUENCY AND SEVERITY RATES, 1915 TO 1919, BY DEPARTMENTS.

Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Bessemer	5,450	2	2	65	69	1.2	1.2	39.8	42.2	7.34	0.37	0.90	8.61
Open hearths	20,525	7	3	351	361	1.1	.5	57.0	58.6	6.82	.24	1.00	8.06
Foundries	10,222	2	2	235	239	.7	.7	76.6	78.0	3.92	.20	1.68	5.80
Blast furnaces	17,621	4	1	185	190	.8	.2	35.0	36.0	4.54	.14	.82	5.50
Fabricating	11,110	1	4	192	197	.3	1.2	57.6	59.1	1.80	.36	.94	3.10
Yards	9,819	1	1	102	104	.3	.3	34.6	35.2	2.04	.10	.80	2.94
Mechanical	24,752	2	2	380	384	.3	.3	51.8	52.4	1.62	.08	.84	2.54
Plate mills	14,711	......	3	299	302	......	.7	67.7	68.4	......	.75	1.11	1.86
Heavy rolling mills	27,123	......	9	307	316	......	1.1	37.7	38.8	......	.92	.75	1.67
Sheet rolling mills	5,920	......	1	39	40	......	.6	22.0	22.6	......	.17	.72	.89
Tube mills	11,621	1	.....	63	64	.3	.....	18.6	18.9	......	.19	.54	.73
Electrical	4,191	......	.....	32	32	......	.....	25.5	25.5	......	.....	.53	.53
Miscellaneous	55,534	7	8	860	875	.4	.5	51.6	52.5	2.52	.61	.96	4.09

CHART 5.—FALLING OBJECTS AS A CAUSE OF ACCIDENT.



HANDLING OBJECTS AND TOOLS AS A CAUSE OF ACCIDENT.

Since the important matter in the group "Handling objects and tools" is the relation between frequency and severity, the summary table and chart are introduced first.

TABLE 15.—HANDLING OBJECTS AND TOOLS AS A CAUSE OF ACCIDENT: NUMBER OF CASES, AND ACCIDENT FREQUENCY AND SEVERITY RATES, 1915 TO 1919, BY DEPARTMENTS.

Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Sheet rolling mills	5,920	....	6	386	392	....	3.4	217.3	220.7	....	1.86	3.63	5.49
Mechanical	24,752	1	24	1,064	1,089	0.1	3.3	143.3	146.7	0.81	2.53	1.91	5.25
Foundries	10,222	....	6	546	552	....	2.0	178.0	180.0	....	2.18	2.21	4.39
Tube mills	11,265	1	6	214	221	.3	1.8	63.3	65.4	1.78	1.15	1.13	4.06
Blast furnaces	17,621	1	7	576	584	.2	1.3	109.0	110.5	1.14	1.48	1.41	4.03
Open hearths	20,525	1	13	867	881	.2	2.1	140.8	143.1	.97	.90	1.76	3.63
Yards	9,819	....	6	294	300	....	2.0	99.8	101.8	....	1.78	1.58	3.36
Heavy rolling mills	27,123	....	19	761	780	....	2.3	93.5	95.8	....	1.47	1.36	2.83
Plate mills	14,711	....	8	613	621	....	1.8	138.9	140.7	....	.75	1.74	2.49
Bessemer	5,450	....	4	128	132	....	2.4	78.3	80.7	....	.73	1.52	2.26
Electrical	4,191	....	4	84	88	....	3.2	66.8	70.0	....	1.31	.93	2.24
Fabricating	11,110	....	4	405	409	....	1.2	121.5	122.7	....	.36	1.64	2.00
Miscellaneous	55,534	....	40	2,612	2,652	....	2.4	156.8	159.2	....	1.39	2.24	3.63

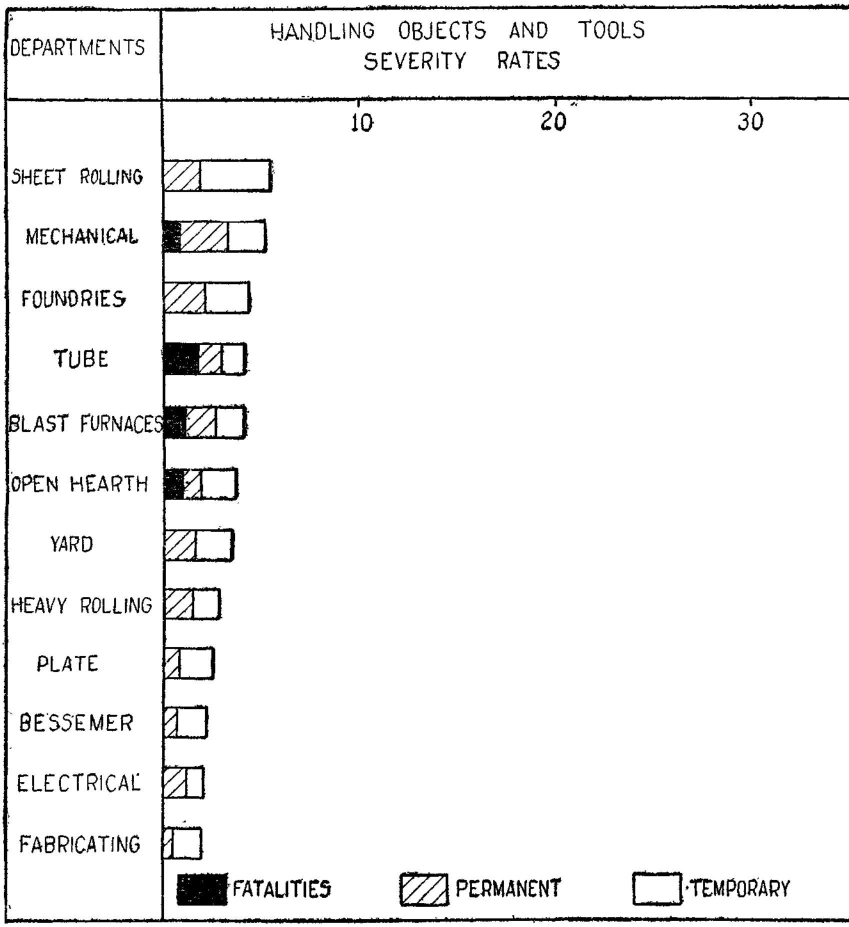
As might be expected the notable feature of this table is the high frequency in contrast with a relatively low severity. In the preceding study of this subject (Bulletin No. 234) objects dropped in handling were grouped with falling bodies. This was perfectly logical but did not direct attention to proper corrective measures as positively as the present arrangement. The result of that grouping was to make "falling bodies" head the list in frequency. The transfer of objects dropped in handling to the group where they are now located puts this group much in the lead in the matter of frequency.

The highest frequency is found in the sheet-rolling department (220.7 cases per 10,000,000 hours' exposure). The highest frequency found elsewhere is in the "power vehicle" cause group, yard department (165.3 cases). In general the majority of the departments have a higher frequency rate in the "handling of objects and tools" cause group than in any other.

The condition as to severity is the precise opposite. It is this cause group more than any other which has to a degree misled the safety movement into the idea that the chief results of its efforts are to be secured by bringing about greater care on the part of the men. The reduction of minor injury such as occurs in connection with the handling of tools and objects has been the result of the response of the men to efforts to interest and instruct them. It is a very notable and worth-while accomplishment, but it does not go to the heart of the matter. No one can observe the black portion of the bars of the charts illustrating this chapter without realizing that death is the shadow which lies over the industry. It is that shadow that efforts should be made to lessen. To do so involves a kind of effort and an expenditure of money which we have not yet undertaken.

Table 16 contains the details regarding this cause group.

CHART 6.—HANDLING OBJECTS AND TOOLS AS A CAUSE OF ACCIDENT



This detail table does not seem to call for much comment. It is noticeable that on the whole the glancing or slipping of tools in the hands of the workman himself is the most serious in this group of causes. Reference to Chart 6 will show that deaths occurred in four departments. On following up the individual cases it was found that in one case the slipping of a bar used as a pry resulted in the man receiving a blow in the abdomen which ultimately caused death. In another case a similar slipping allowed the man to fall and receive fatal injuries. In nearly every case it was evident or reasonably inferred that there was some fault with the tool or appliance. Many plants have entirely failed to develop an adequate system of care and upkeep for their tools.

TABLE 16.—HANDLING OBJECTS AND TOOLS AS A CAUSE OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Objects dropped in handling	0.49	0.46	0.67	0.49	0.39	0.87	0.22
Caught between object handled and other object	.39	.84	.94	1.16	.84	.85	.79
Lifting, causing strain	.17	.22	.18	.35	.18	.20	.14
Handling glass	(1)	......	......	.01	(1)	......	......
Handling sheet metal	......	......	.01	......	(1)	......	......
Handling objects with protruding nails	(1)	......	.01	.02	(1)	(1)	......
Handling other sharp objects	.71	.12	.19	.38	.04	.24	.09
Handling trucks or barrows, collide with person	......	.01	(1)	(1)	......	......	......
Handling trucks or barrows, collide with objects	(1)	.02	(1)	(1)	......	(1)	.01
Handling trucks or barrows, overturn	.04	.04	.02	.02	(1)	.01	.02
Handling trucks or barrows, objects fall from	.01	.02	.01	.06	.02	.01	.01
Handling trucks or barrows, other accidents	.01	.06	.04	.04	.02	.02	.05
Tools in hands of worker:							
Glance or slip	1.33	.21	1.19	1.60	.44	.23	.24
Break or come apart	.01	......	.03	.02	(1)	.01	.04
Objects fly from, not otherwise specified	.73	.04	.04	.03	.03	(1)	.01
Objects fly from, nails and spikes	......	......	......	(1)	.22	......	......
Objects fly from, metal chips	.01	.01	.16	.12	.14	(1)	.56
Objects fly from, stone or cement	.01	......	(1)	......	(1)	......	(1)
Tools in hands of fellow worker:							
Glance or slip	.07	.10	.07	.05	.03	.04	.02
Break or come apart	(1)	......	.02	.01	(1)	(1)	.01
Objects fly from, not otherwise specified	.01	(1)	(1)	......	.22	(1)	......
Objects fly from, metal chips	......	......	(1)	(1)	.22	......	.03
Objects fly from, stone or cement	......	......	(1)	......	......	......	......
Unclassified	.01	.04	.05	.02	.03	.01	1.82
Total	4.03	2.26	3.63	4.39	2.83	2.49	4.06

Accident cause.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Objects dropped in handling	0.55	0.39	0.29	0.68	0.80	0.68
Caught between object handled and other object	.50	.74	.70	.36	.51	.82
Lifting, causing strain	.28	.12	.12	.27	.26	.27
Handling glass	......	(1)	.03	(1)	(1)	.01
Handling sheet metal	1.76	.01	......	.01	......	.06
Handling objects with protruding nails	......	(1)	......	.01	(1)	.01
Handling other sharp objects	.03	.03	.30	.14	.66	.34
Handling trucks or barrows, collide with person	(1)	......	......	.01	......	(1)
Handling trucks or barrows, collide with objects	......	......	......	(1)	......	.04
Handling trucks or barrows, overturn	(1)	.03	......	(1)	.04	.02
Handling trucks or barrows, objects fall from	.01	.01	.07	.34	.03	.06
Handling trucks or barrows, other accidents	.02	.05	.11	.07	.10	.20
Tools in hands of worker:						
Glance or slip	1.70	.28	.45	.40	.22	.53
Break or come apart	.06	(1)	......	.02	(1)	.02
Objects fly from, not otherwise specified	.08	.05	.02	.77	.65	.13
Objects fly from, nails and spikes	......	.01	......	(1)	......	(1)
Objects fly from, metal chips	......	.09	.04	.57	.03	.14
Objects fly from, stone or cement	......	......	......	.01	......	(1)
Tools in hands of fellow worker:						
Glance or slip	.14	.05	.08	49	.04	.10
Break or come apart	.02	.02	......	(1)	......	(1)
Objects fly from, not otherwise specified	(1)	.03	......	.01	......	(1)
Objects fly from, nails and spikes	......	......	......	......	......	.11
Objects fly from, metal chips	......	.09	(1)	1.06	(1)	.01
Objects fly from, stone or cement	......	......	......	(1)	......	(1)
Unclassified	.39	.02	.03	.02	.03	.08
Total	5.49	2.00	2.24	5.25	3.36	3.63

1 Less than 0.005.

Next to slipping and glancing of tools comes being caught between the object handled and some other object; and next, objects dropped in handling. The remedy for these conditions lies in two directions, the further substitution of mechanical methods of handling objects needing to be moved and the development of greater skill and care on the part of the men.

MISCELLANEOUS CAUSES OF ACCIDENT.

Table 17 deals with the miscellaneous causes which can not be brought under any of the classifications hitherto presented.

TABLE 17.—MISCELLANEOUS CAUSES OF ACCIDENT: SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.
Asphyxiation	9.14	....	0.03	(1)	(1)	....	....
Cold	(1)	....	....	....	(1)	....	....
Doors, windows, etc	(1)	(1)	(1)	0.01	(1)	(1)	....
Flying objects, not otherwise classified	2.01	1.37	.75	.93	1.07	0.17	0.14
Heat	(1)	(1)	.01	(1)	.01	2.73	1.78
Nails and sharp objects stepped on	.02	....	.03	.09	....	.03	.01
Violence	(1)	....	.01	.02	.02	.02	....
Striking against objects	.11	.19	.16	.15	.15	.20	.25
Uneven footing	.08	.08	.11	.06	.06	.05	.01
Moving objects, not otherwise classified	.36	.07	1.00	.10	1.58	.19	2.15
All other	2.31	.04	.05	.20	.07	.04	.01
Total	14.03	1.74	2.13	1.57	2.96	3.43	4.35

Accident cause.	Sheet-rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
Asphyxiation	....	(1)	4.77	0.82	(1)	1.45
Cold	....	0.01	....	.01	....	(1)
Doors, windows, etc	....	....	(1)	.01	(1)	.01
Drowning	....	1.80	....	....	....	(1)
Flying objects, not otherwise classified	0.09	.30	.07	1.60	7.59	1.26
Heat	....	....	.02	(1)	(1)	.01
Nails and sharp objects stepped on	....	.07	.05	.05	.02	.04
Violence	.01	....	....	....	....	.38
Striking against objects	.88	.20	.13	.96	.15	.52
Uneven footing	.13	.04	.14	.06	.11	.09
Moving objects, not otherwise classified	.05	.17	.03	.06	2.08	.58
All other	.20	(1)	.02	.61	2.14	.97
Total	1.37	2.59	5.25	4.17	12.09	5.31

[1] Less than 0.005.

The notable feature of this table is the evidence which it affords that asphyxiating gas is in blast furnaces a very serious menace. In the blast furnaces 9.14 out of the 14.03 days lost per 10,000 hours' exposure were due to this cause. It is probably not wholly typical that electrical workers had 4.77 out of 5.25 days.

No attempt has been made to trace the effects of asphyxiating gas from year to year during this five-year period, but the indications are that the situation has not greatly changed for the better.

The influence of uneven footing is worth a moment's attention. Cases of slipping and stumbling are placed under the head of "Falls of persons." Those here recorded are cases in which a piece of material lying on the ground caused a turning of the ankle or a straining of the knee. The constancy with which this appears in all the departments emphasizes again the importance of keeping the plants in good order. An untidy plant is an unsafe plant.

Table 18 and Chart 7 summarize the facts regarding miscellaneous causes.

TABLE 18.—MISCELLANEOUS CAUSES OF ACCIDENT: NUMBER OF CASES AND ACCIDENT FREQUENCY AND SEVERITY RATES, 1915 TO 1919, BY DEPARTMENTS.

Department.	Equivalent full-year workers.	Number of cases.				Accident frequency rates (per 10,000,000 hours' exposure).				Accident severity rates (per 10,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Blast furnaces	17,621	11	3	400	414	2.1	0.6	75.7	78.4	12.49	1.02	0.52	14.03
Yards	9,819	4	4	177	185	1.4	1.4	60.1	62.9	8.15	3.19	.75	12.09
Electrical	4,191	1	.....	88	89	.8	.....	70.0	70.8	4.77	.....	.48	5.25
Tube mills	11,265	2	2	113	117	.6	.6	33.4	34.6	3.55	.27	.53	4.35
Mechanical	24,752	2	7	540	549	.3	.9	72.7	73.9	1.62	1.94	.61	4.17
Plate mills	14,711	2	.....	286	288	.5	.....	64.8	65.3	2.72	.....	.71	3.43
Heavy rolling mills	27,123	3	1	327	331	.4	.1	40.2	40.7	2.21	.22	.53	2.96
Fabricating	11,110	1	2	298	301	.3	.6	89.4	90.3	1.80	.18	.61	2.59
Open hearths	20,525	1	2	449	452	.2	.4	72.9	73.5	.97	.58	.58	2.13
Bessemer	5,450	....	1	90	91	....	.6	55.0	55.6	....	1.10	.64	1.74
Foundries	10,222	....	3	263	266	....	1.0	85.8	86.8	....	.78	.79	1.57
Sheet rolling mills	5,920	....	1	129	130	....	.6	72.6	73.2	....	.17	1.20	1.37
Miscellaneous	55,534	10	11	997	1,018	.6	.7	59.8	61.1	3.60	.97	.74	5.31

CHART 7.—MISCELLANEOUS CAUSES OF ACCIDENT.

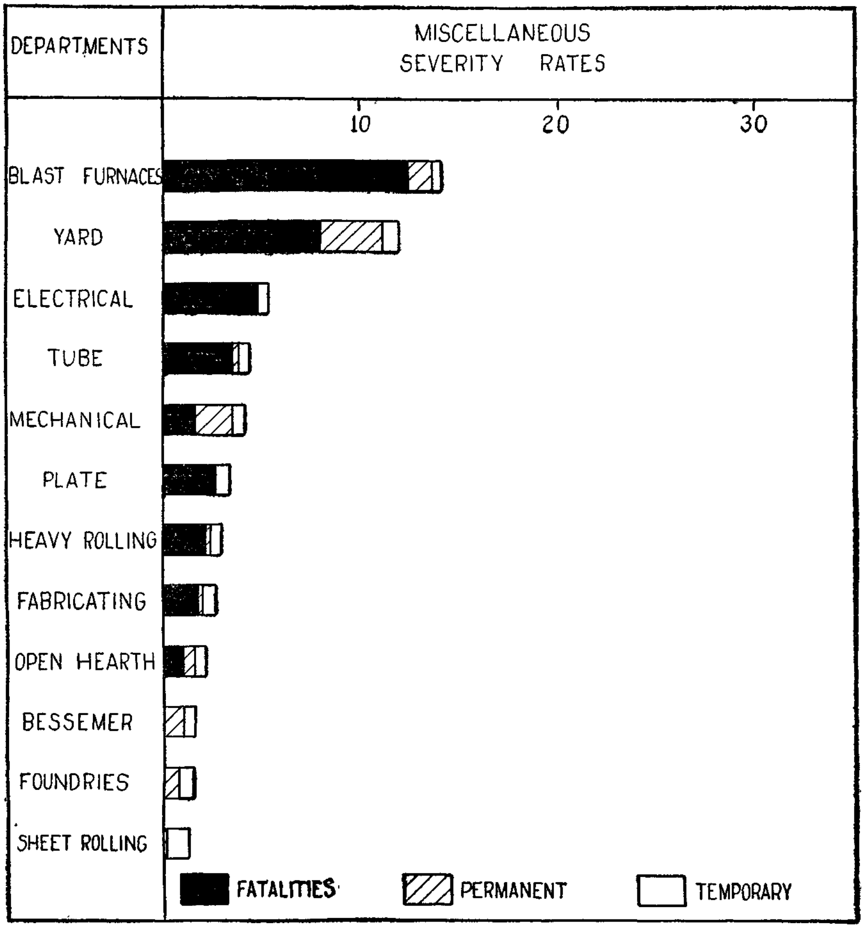


Table 19 summarizes the situation from a slightly different angle. It brings out clearly some points of interest. It makes very plain the fact that frequency and severity are not indications of the same thing. For example, following the rates for "handling" it will be seen that with scarcely an exception the frequency rate for this cause group is in excess of any other, while with almost equal constancy its severity rate is at or near the foot of the list. It may also be noted that while the number of cases due to "machinery" is not constantly above the middle of the list the severity rates are at the top in 10 departments out of the 13.

TABLE 19.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR SPECIFIED DEPARTMENTS, 1915 TO 1919, BY ACCIDENT CAUSE GROUPS.

Accident cause group.	Blast furnaces.	Bessemer.	Open hearth.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Miscellaneous.
	Frequency rates (per 10,000,000 hours' exposure).												
Machinery	28.9	33.0	65.5	105.6	55.5	84.3	35.2	41.1	158.7	60.5	85.9	34.3	72.7
Power vehicles	28.2	30.0	32.8	6.8	7.5	4.5	2.7	......	3.9	5.6	7.1	165.3	12.7
Hot substances	82.5	73.4	126.9	55.5	30.1	36.8	16.0	22.0	12.3	98.7	24.8	17.3	38.6
Falls of worker	37.7	28.7	45.8	25.1	25.0	27.2	11.2	22.5	28.2	58.1	39.6	24.8	32.8
Falling objects	36.0	42.2	58.6	78.0	38.8	68.4	18.9	22.6	59.1	25.5	52.4	35.2	52.5
Handling objects and tools	110.5	80.7	143.1	180.0	95.8	140.7	65.4	220.7	122.7	70.0	146.7	101.8	159.2
Miscellaneous	78.4	55.6	73.5	86.8	40.7	65.3	34.6	73.2	90.3	70.8	73.9	62.9	61.1
	Severity rates (per 10,000 hours' exposure).												
Machinery	14.52	16.74	19.25	13.05	10.71	12.68	12.29	3.54	18.55	31.38	11.16	13.57	11.59
Power vehicles	18.96	13.50	11.77	.12	5.92	.07	.80	......	.10	.16	2.76	54.35	6.44
Hot substances	18.54	24.03	16.65	7.02	5.70	3.14	2.18	.28	1.95	24.98	2.79	.27	3.94
Falls of worker	7.41	1.36	1.04	2.46	.62	.41	2.13	.41	2.30	11.21	4.93	.38	3.16
Falling objects	5.50	8.61	8.06	5.80	1.67	1.86	.73	.89	3.10	.53	2.54	2.94	4.09
Handling objects and tools	4.03	2.26	3.63	4.39	2.83	2.49	4.06	5.49	2.00	2.24	5.25	3.36	3.63
Miscellaneous	14.03	1.74	2.13	1.57	2.96	3.43	4.35	1.37	2.50	5.25	4.17	12.09	5.31

CHAPTER IV.—THE PHYSICAL CAUSES OF ACCIDENT—THE DEPARTMENTS ANALYZED.

In the preceding chapter the important departments have been contrasted with regard to the principal cause groups and the detailed causes under those groups.

In this chapter the purpose is to analyze these departments, bringing out whenever possible what has happened from year to year over a period extending from 1905 to 1914. It is not thought necessary to extend this minute analysis to the 5-year period, 1915 to 1919, since the effect of the various preventive measures is clearly shown in the earlier period and their continued effect is evident on comparing the two periods.

BLAST FURNACES.

In Table 20 the cause rates for blast furnaces are shown for each year from 1905 to 1914.

TABLE 20.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR BLAST FURNACES, 1905 TO 1914, BY YEARS, AND BY ACCIDENT CAUSES.

Accident cause.	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).									
Working machines	......	2.10	1.90	2.10	1.33	0.43	1.43	0.77	0.80	......
Cranes and hoists	2.07	5.30	2.77	3.13	5.37	1.73	2.40	1.53	2.00	0.87
Hot substances:										
Breakouts	3.80	8.47	2.97	.80	2.03	......	......	......	......	......
Sparks and splashes	15.97	6.07	10.43	3.40	4.93	4.20	4.10	3.43	4.23	1.70
Spills	......	.27	.20	......	......	.23	......	......	......	......
Explosions	1.03	2.10	1.27	1.30	.90	.73	......	.37	1.00	.57
Furnace slips	4.50	4.50	1.90	5.50	.67	.50	1.20	......	......	......
Gas flames	3.10	4.77	2.33	2.10	1.57	1.73	2.67	......	.20	.30
Hot water, etc	21.17	9.77	14.70	9.93	4.70	3.93	5.30	5.13	3.23	3.17
Total, hot substances	49.57	35.95	33.80	23.03	14.80	11.32	13.27	8.93	8.66	5.74
Falling objects	38.50	21.40	18.53	13.63	12.10	14.30	5.53	6.67	6.23	3.17
Falls of worker	7.63	7.93	7.47	8.63	4.70	7.87	3.37	5.30	2.60	4.30
Handling objects and tools	14.90	8.70	10.87	8.63	10.10	10.83	9.43	7.43	5.63	4.30
Power vehicles	1.40	1.60	1.90	1.07	1.13	1.97	.23	.60	.40	......
Asphyxiating gas	2.07	7.40	2.97	1.07	2.30	4.67	.97	1.13	.40	1.40
Unclassified	22.90	15.07	18.93	12.57	15.70	8.63	5.30	8.20	3.63	5.17
Not reported	2.43	5.03	2 13	.27	1.80	.50	.23	.97	......	......
Total	141.47	110.48	101.27	74.13	69.33	62.25	42.16	41.53	30.35	24.95
	Accident severity rates (per 1,000 hours' exposure).									
Working machines	(1)	1.80	0.03	0.47	0.03	......	0.03	0.07	......	......
Cranes and hoists	(1)	3.63	.40	.07	1.60	0.13	.03	.13	1.40	0.03
Hot substances:										
Breakouts	4.70	10.77	.07	.03	3.07	......	......	......	......	......
Sparks, etc	.13	.30	.53	.07	.07	.07	.03	.03	.03	.23
Spills	......	......	......	......	......	.03	......	......	......	......
Explosions	.03	.03	.17	.03	.03	......	......	......	......	.20
Furnace slips	.63	.07	1.60	.20	......	......	.07	......	......	......
Gas flames	2.37	2.00	.03	......	.03	.03	1.63	......	......	......
Hot water, etc	.20	1.97	.30	.20	.07	.07	.30	.03	.40	.03
Total, hot substances	8.06	15.14	2.70	.53	3.27	.20	2.03	.06	.43	.46
Falling objects	2.80	3.73	.23	.33	1.73	.17	.07	.07	.03	.07
Falls of worker	......	1.87	2.97	1.93	3.07	3.43	.10	.07	1.40	.10
Handling objects and tools	.53	2.03	.10	.10	.07	.33	.13	.13	.23	.23
Power vehicles	......	3.57	2.93	.13	1.50	.53	1.60	......	(1)	......
Asphyxiating gas	2.33	3.83	5.73	3.50	3.07	1.70	1.60	1.30	1.33	3.87
Unclassified	......	......	.80	1.00	.27	.33	.07	.10	.07	.03
Not reported	......	......	.03	......	.03	......	......	.03	......	......
Total	13.72	35.60	15.92	8.06	14.64	6.82	5.66	1.96	4.89	4.79
Number of workers	*961*	*1,262*	*1,566*	*1,274*	*1,486*	*1,353*	*1,380*	*1,749*	*1,658*	*1,160*

1 Less than 0.005.

Considering the reduction in accident rates, both frequency and severity, occurring in the blast furnaces during this period, it will be observed that there is a very considerable regularity in the distribution of this decrease for each of the causes enumerated. In some instances, however, the reductions are striking, even spectacular. For example, in the case of "hot substances," the severity rate for 1905 is 8.06 days per 1,000 hours' exposure and for 1906 15.14 days. This declines to 0.46 day for 1914. In the blast furnace plants included in this tabulation, the severity rate of one form of injury due to hot substances, namely, "breakouts," which were of very great importance during the early years, entirely disappears from 1910 onward. A study of the table will reveal the changes in the situation regarding the different cause groups.

WORKING MACHINES.

In the blast furnaces there are comparatively few pieces of apparatus which can be included under this heading. In two years, however, 1906 and 1908, the table shows high severity rates for machines. For 1906 it is 1.80 days per 1,000 hours' exposure. This comparatively high rate was due mainly to a fatality at the pig machine. In this machine an endless belt carries a series of cast-iron pans into which molten metal is poured. The belt moves forward carrying the filled pans and the metal is cooled by the application of water sprays, or the pans may be entirely immersed in a water bath. At the extreme limit of the excursion of the belt, the pigs fall from the pans as they pass the last rollway, forming a stock pile, or in some cases fall directly into cars for transportation. In some cases a pig, instead of dropping from the pan, adheres and is carried back by the belt along the underside of the apparatus. Such a "sticker" is liable to fall from the pan at any point of the return movement. In the case under consideration this happened just when the pan had reached a passageway, the pig striking a man who was passing through and killing him. As a result this particular passage was closed and in other similar cases where the passage was particularly desirable a guard was placed overhead which would catch a falling pig.

Again, for 1908 there is a high rate (0.47 day), due largely to a man's foot being crushed in the mud gun. Plate 1 illustrates this machine and shows at the point marked "A" a funnel through which clay for closing the tap hole is fed. In the older type of mud gun there was simply an opening into the barrel of the gun and quite often a man would press the clay into place with his foot. In the case under consideration, and in several others, the foot was caught by the moving piston of the machine and severely injured, in this case necessitating amputation.

Since the number of accident cases in connection with machines is decidedly small, comparisons between the different years must be made with considerable caution. It is evident, however, that some definite improvement is evidenced by the figures.

CRANES AND HOISTS.

In blast-furnace operations the usual type of crane is utilized to some extent. There are two forms of hoisting apparatus peculiar to the blast furnace. In any furnace of considerable size the han-

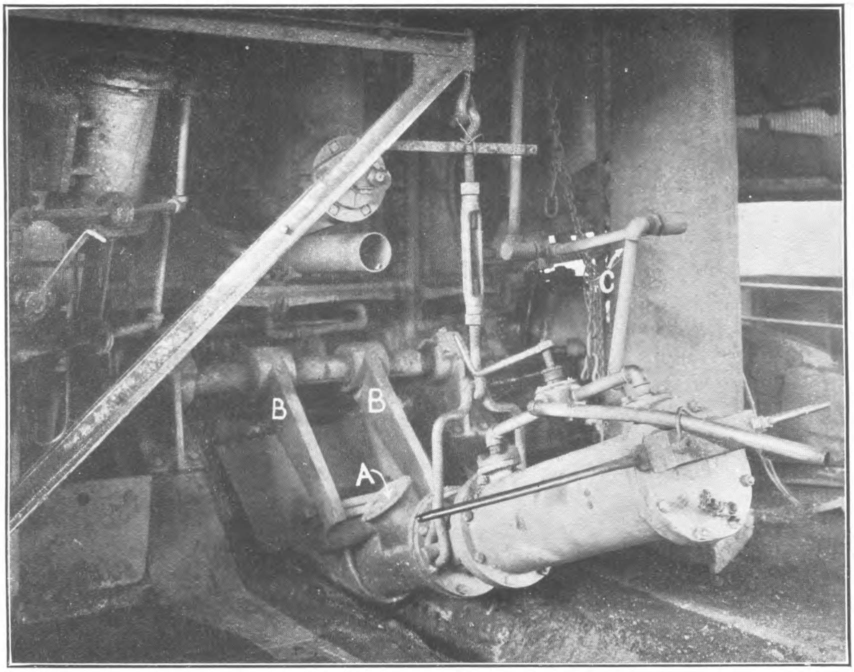


PLATE 1.—MUD GUN IN POSITION FOR CLOSING TAP HOLE.

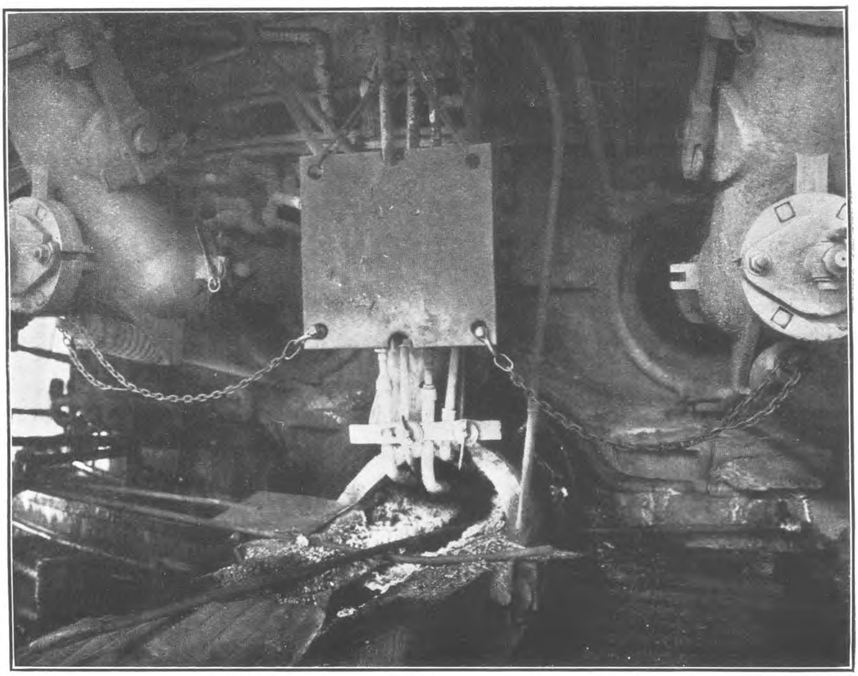


PLATE 2.—CINDER NOTCH, WITH GUARD.

dling of the ore will be accomplished by the ore bridge. This is essentially a very much magnified gantry crane. The other form of hoisting apparatus is that by which the materials are elevated to the top of the furnace and dumped into the stack. Since in both these forms the operation is almost exclusively mechanical, the operator simply determining the movements by pulling levers and manipulating electric circuits, the accidents from them are not very numerous, although when accidents do occur they are apt to be quite severe.

Turning now to the figures shown in Table 20, it appears that in the initial year, 1905, the frequency rate was low and the severity rate almost nothing. In 1906, however, in connection with the increased industrial activity, the rates rose very rapidly. Considering years of a similar degree of activity 1906 may be compared with 1913. The frequency rate in 1906 was 5.30 cases and in 1913 was 2.00 cases, a decline of 62 per cent, the severity rate at the same time declining 62 per cent, from 3.63 days to 1.40 days. It is known that these reductions were associated with important structural changes. For example, when repairs are to be made at the top of a furnace it is frequently necessary to attach the tackle to some part of the furnace top. In the older types of furnaces no special provision was made for this purpose and stairways and platforms by which the top of the furnace might be reached were very inadequate or entirely wanting. This resulted in a condition of hazard, which is strongly reflected in the accident rates for hoisting and also in those for falls of the workers.

No change has contributed more definitely to lessen hazard about the blast furnace than the complete revision of stairways, railings, platforms, and other means of access which is to be found in all modern installations.

EXPLOSIVES, ELECTRICITY, AND HOT AND CORROSIVE SUBSTANCES.

This group of causes is naturally of peculiar importance and interest in the blast furnace. The essential process of this department is the application of a high degree of heat to refractory materials and throughout the process the hazards due to such heat are encountered.

Considering again the years 1906 and 1913, which are closely similar in industrial and labor conditions, the following decline in accident rates due to hot substances may be noted: Frequency, from 35.95 to 8.66 cases per 1,000,000 hours' exposure, a reduction of 76 per cent, and severity, from 15.14 days to 0.43 day per 1,000 hours' exposure, a reduction of 97 per cent. It can not be assumed that these very remarkable reductions are to be found throughout the blast-furnace plants of the country, but it may be argued that the same attention to improved construction which has affected these particular mills will, if extended, similarly affect the rates in all such furnaces.

It is desirable to examine some of the divisions of this cause group in order to secure a more detailed view of the changes which have occurred.

BREAKOUTS.

In the older type of furnaces it was not an infrequent occurrence that the walls of the furnace would be completely worn through by the hot metal and that the outrush of molten iron which would follow would cause serious loss of life. A case is on record where such a "breakout" resulted in the death of 14 men. When the record as shown in the table is followed, it is found that these occurrences were by all odds the most serious hazard in the earlier years. The year 1905 shows a severity rate of 4.70 days; 1906, 10.77 days. Up to 1909 there continued to be difficulty from this cause, but from that year breakouts entirely disappeared in the plants under consideration. This disappearance was due entirely to improved construction, which has now reached a point where events of this character should be regarded as unnecessary.

SPARKS AND SPLASHES.

Injuries from this source are quite numerous and their severity is great enough to warrant particular attention. Danger of this kind arises particularly in drawing the cinder which floats upon the surface of the molten iron and in connection with tapping off the molten iron itself. Plate 2 shows a method of guarding the cinder notch which has proved reasonably effective. It consists of a shield which can be lowered into a position in front of the notch when it is necessary to draw off the cinder. Plate 3 illustrates a method of opening the tapping hole of the furnace which, unfortunately, still continues in a good many plants. The line of men who operate the bar by which the clay plug closing the tapping hole is broken through are in such position that when the molten metal comes pouring through there are many chances that the small explosions which are very apt to occur may throw the metal upon the men and cause severe burns. Plate 4 illustrates the substitution of an air drill for the hand operated tapping bar. The number of men necessary for the operation is greatly reduced. The tapping hole and the adjacent runner are securely screened and the dress of the men includes such precautions as the use of leggins. There is probably one other precaution in this operation which might be urged. Burns of the eye are not of very frequent occurrence but they happen from time to time, producing injury all the way from a brief disability to actual loss of the eye. The use of protective goggles has become quite general in foundries, and there would seem to be no reason why the same protection should not be afforded in the cast house.

As the metal flows from the tapping hole it is necessary to direct its course from the main runner in various directions. This is accomplished by the use of heavy cast-iron gates. These are of semicircular shape, with a handle projecting from the side. Under the earlier conditions it was necessary for the helper to pick up these gates and drop them in position, getting away if possible quickly enough to avoid the scorching heat and the splashing metal. In a modern cast house the gates are suspended above the runner and lowered into position by a cable or some other mechanism, which can be operated from a distance. Keeping the gates suspended above the runner tends to safety in another particular. When the gates were stored in other parts of the cast house the iron frequently became moist. When necessary to use the gate it would be held for a time over the flowing metal in order to dry off any adherent moisture. This was so hot and disagreeable a task that it was often not thoroughly done. The result would be that when the moist gate came in contact with

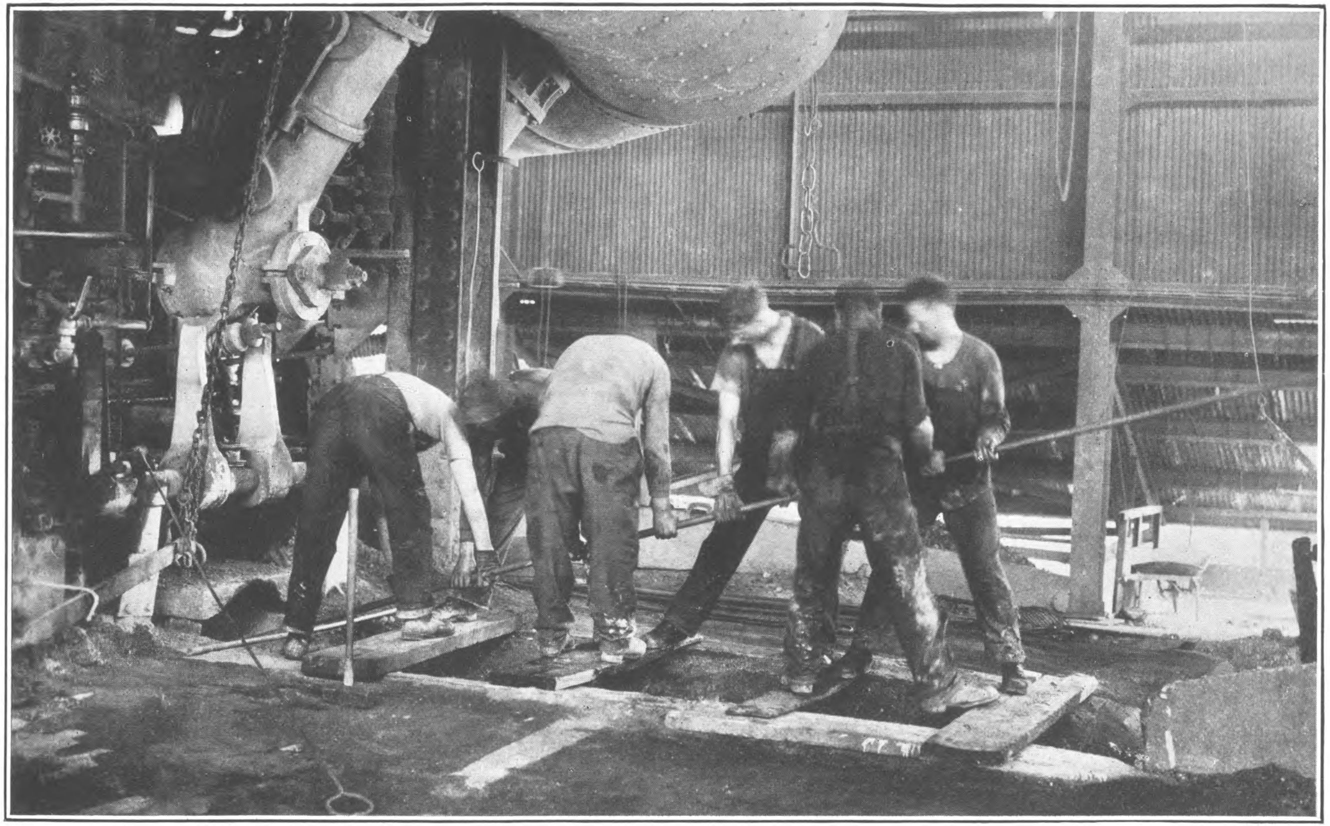


PLATE 3.—OLD, UNSAFE METHOD OF DRILLING A TAPPING HOLE.

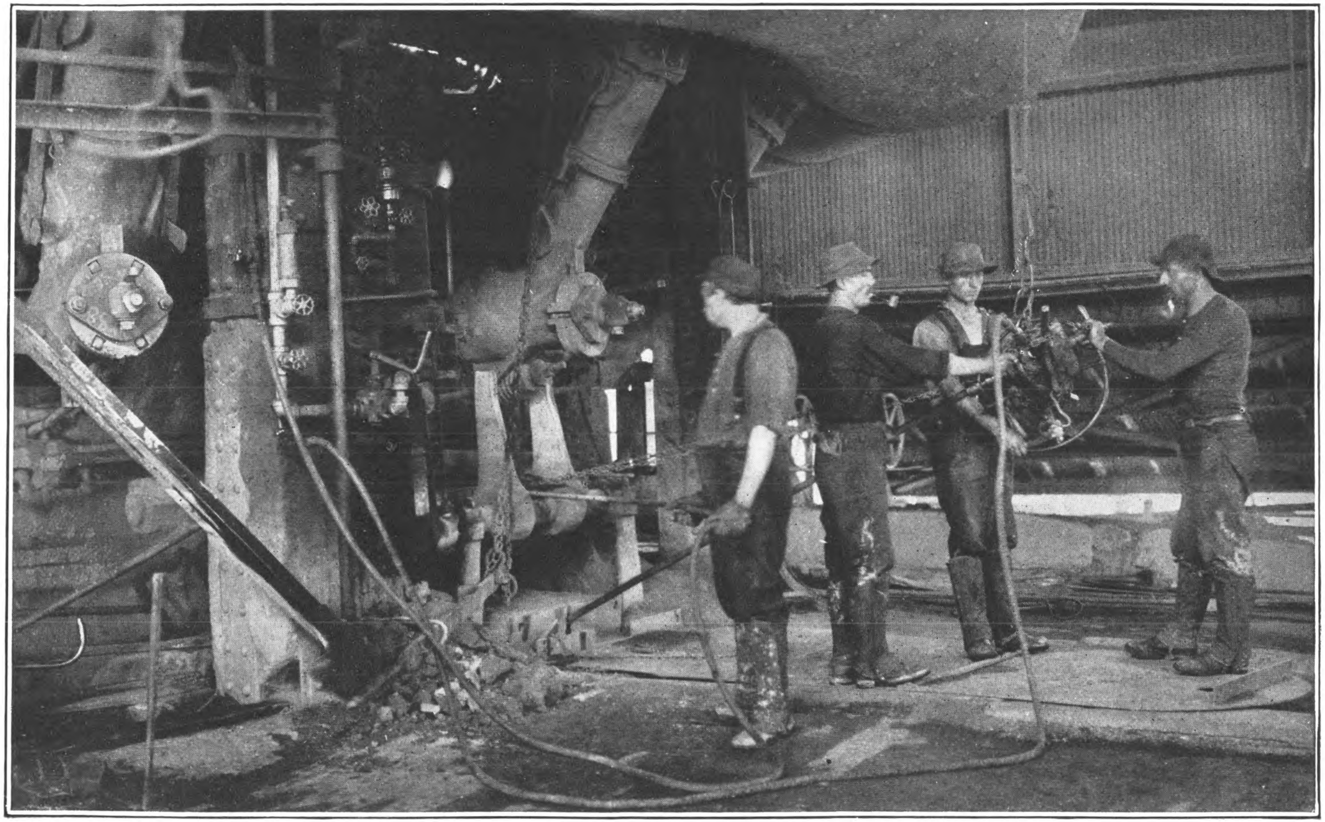


PLATE 4.—IMPROVED METHOD OF DRILLING A TAPPING HOLE.

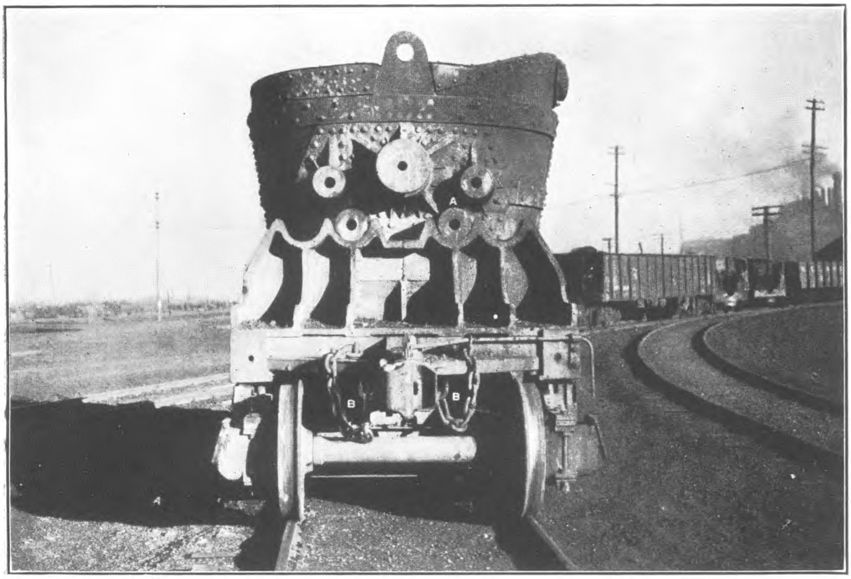


PLATE 5.—HOT METAL LADLE AND CAR, SHOWING DOUBLE TRUNNIONS AND SAFETY CHAINS.

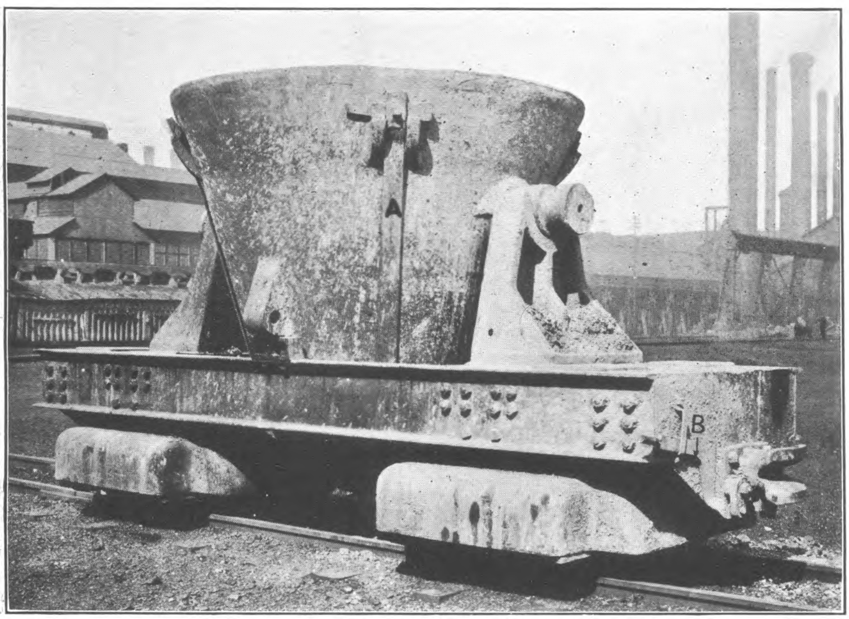


PLATE 6.—AUTOMATIC COUPLER ON CINDER LADLE CAR.

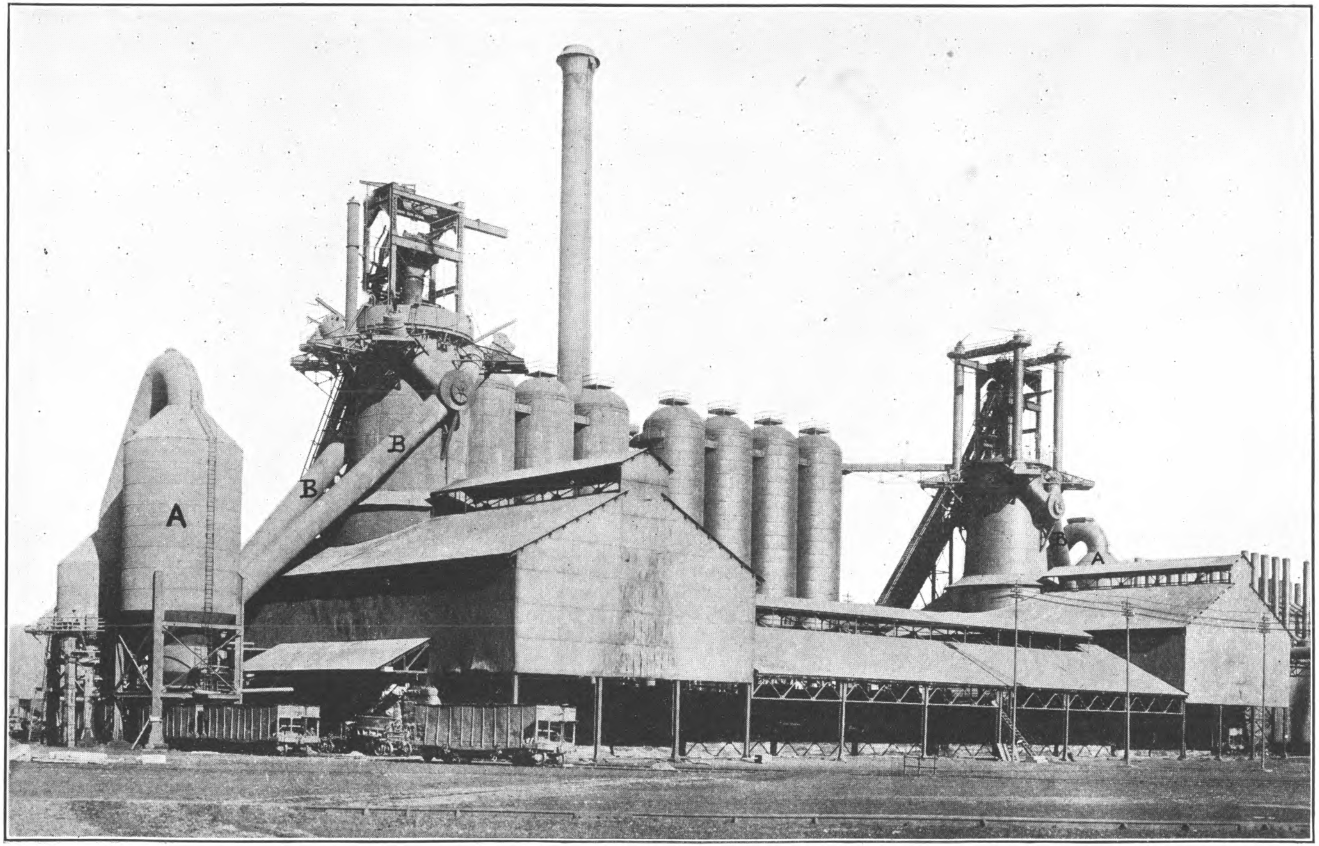


PLATE 7.—MODERN BLAST FURNACE PLANT, SHOWING DUST CATCHER.

the molten metal an explosion would be caused of sufficient violence to scatter the metal pretty well over the area of the cast house. The method described above entirely prevents this accumulation of moisture.

Splashing of the molten metal is apt to occur in connection with its transportation. Two conditions, which have been to a considerable degree remedied, were likely to produce dangerous splashing: (1) The ladle cars sometimes had to be coupled together after hot metal or cinder had been placed in them. If the coupling had to be done by hand there was great danger that when the cars came together a splash would occur which the man would have great difficulty in escaping. It has been argued, with some reason, that the automatic coupler is not adapted to use on cars of this kind. The molten metal flying out of the ladle was apt to fall upon the coupler and obstruct its action. It has been possible, however, to devise couplers which are successful in use. (See Plates 5 and 6.) (2) The ladles used in transporting molten metal are provided with trunnions, to which the large hooks carried by the cranes are attached when it is desired to pour the metal from the ladle. For convenience in pouring, these trunnions are placed at a point a little above the center of gravity. When the same trunnions were used for pouring and for supporting the ladle during transportation, great difficulty was experienced in so blocking the ladle that it would not sway or overturn during transportation. Plate 5 illustrates the use of double trunnions for supporting the ladle on the car entirely independent of the larger one used for purposes of pouring. This construction has materially lessened the danger of the metal spilling when the car is moving.

EXPLOSIONS.

As has been stated above, contact with moisture may cause quite a serious explosion in the molten metal. It is also evident from some cases which have occurred that there may be gases generated or contained within the metal which give rise to dangerous explosions. This appears, however, to be of rather minor importance in the blast furnaces.

FURNACE SLIPS.

In the older type of furnace hot stock falling upon the workmen, causing more or less severe burns, was not infrequent. With the advance in construction which has occurred in recent years this form of injury has largely disappeared. In order to show with reasonable clearness how progress has eliminated this source of injury, it is necessary to present, with some degree of detail, the structural features of a modern furnace. The furnace itself consists of three elements: (1) The stack or furnace proper; (2) the blowing engine; (3) the stoves. Plates 7 and 8 illustrate the present development of such furnace. The three elements mentioned represent the successive steps by which the furnace has been evolved. The first form was simply a tower of masonry with a brick lining into the top of which the fuel, ore, and flux were dumped. The gases generated in the smelting process escaped freely from the top of the tower and there took fire, showing a waving torch of flame. Those who can remember such primitive furnaces will recall them as a very striking feature of a night-time landscape. The next step in development was to add to this tower some form of blowing apparatus by which air was forced into the mass of material and combustion and melting hastened (see Plate 8). It was then discovered that still greater efficiency could be attained by warming the air before it was introduced into the tower. This has finally developed into the exceedingly effective stoves of present practice. The furnace proper will show, if considered in vertical section, three portions: (1) At the bottom is a cylindrical portion called the hearth; (2) above the hearth is a funnel-shape portion called the "bosh"; (3) above the "bosh" the furnace has the form of a truncated cone, called the stack. This shape of the upper part of the furnace allows the material which is thrown in at the top to pass downward freely. When the "bosh" is reached the temperature is sufficient to cause melting and the material decreases in bulk. The funnel shape of the "bosh" accommodates this softening and shrinking mass.

Surrounding the furnace near the point where the stack and "bosh" come together is a circular pipe, the "bustle" pipe (see Plate 9). The air forced by the blowing engines passes through one of the stoves and is then forced into this bustle pipe. From the lower side of this pipe a series of smaller pipes extend downward and pass through the wall of the furnace, delivering the heated air among the materials which have come down from the top of the stack.

Thus the small tower in which the early smelting was accomplished has gradually become a very large and very complicated piece of industrial apparatus.

In Plate 7 may be seen the various elements of a blast furnace installation, namely, the stack, the stoves, the engine house, and the accessory pipes by which these parts are brought into relation and the inclined hoistway, by which the various materials, coke, ore, and limestone, which constitute "the burden," are elevated to the top of the furnace.

What is called "a slip" by the furnace man formerly produced one of the most serious hazards connected with the operation of the furnace and even with the best modern construction there is still a degree of danger connected with it. When from any cause the downward movement of the material in the furnace is checked there may occur below this point a burning away of the combustible portion of "the burden" and when this occurs "the burden" above that point may suddenly slip down in the stack. Since this mass may be as much as 20 feet in diameter and 60 feet in height, it is evident that the mechanical effect of a sudden drop, even of a few inches, would be very great.

In order to understand the conditions which may bring about a slip it is necessary to state, in some detail, the processes which go on within the furnace. When the furnace is "blown in" a quantity of fuel in the hearth is ignited. When the entire mass is on fire the feeding in of material at the top of the furnace begins. A portion of this material is coke which on coming down to the burning mass in the hearth takes fire. In accordance with the operative practices of the furnace the bustle pipe is at a certain stage of the process connected up with the furnace by means of short pipes, called "goose necks," which terminate in water-cooled nozzles—the "tuyeres." These, passing through the walls of the furnace, deliver the heated air to the "burden." The burning of the coke produces a high

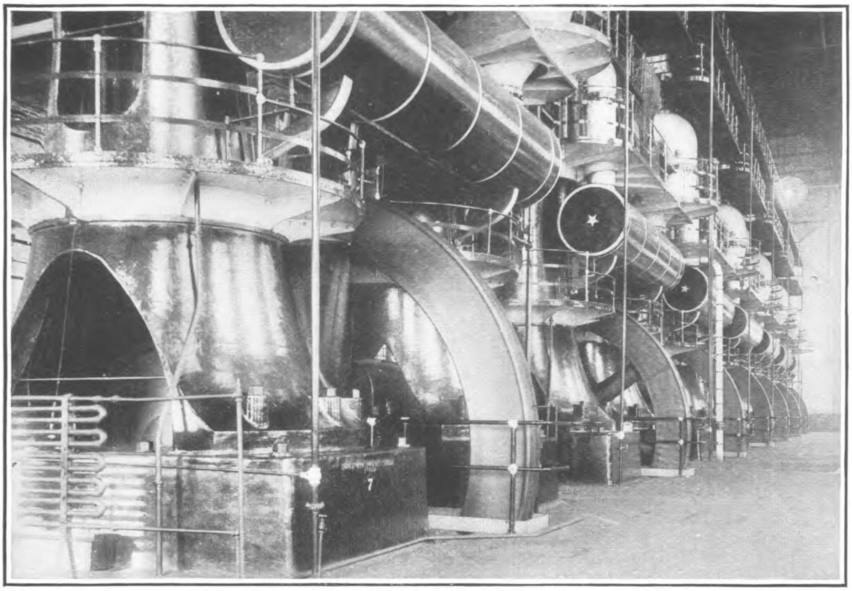


PLATE 8.—BLOWING ENGINES IN BLAST FURNACE PLANT.

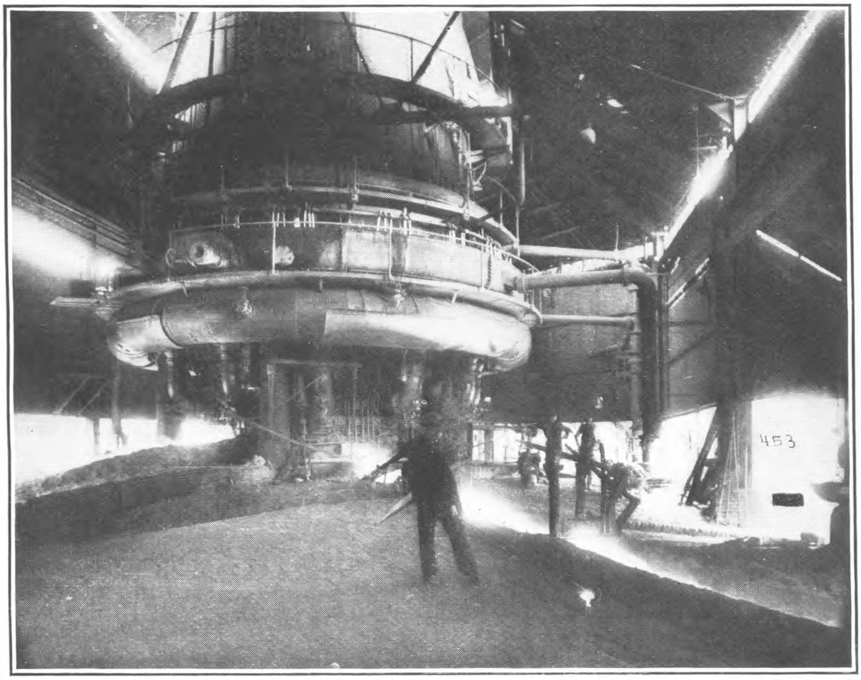


PLATE 9.—BLAST FURNACE, SHOWING BUSTLE PIPE.

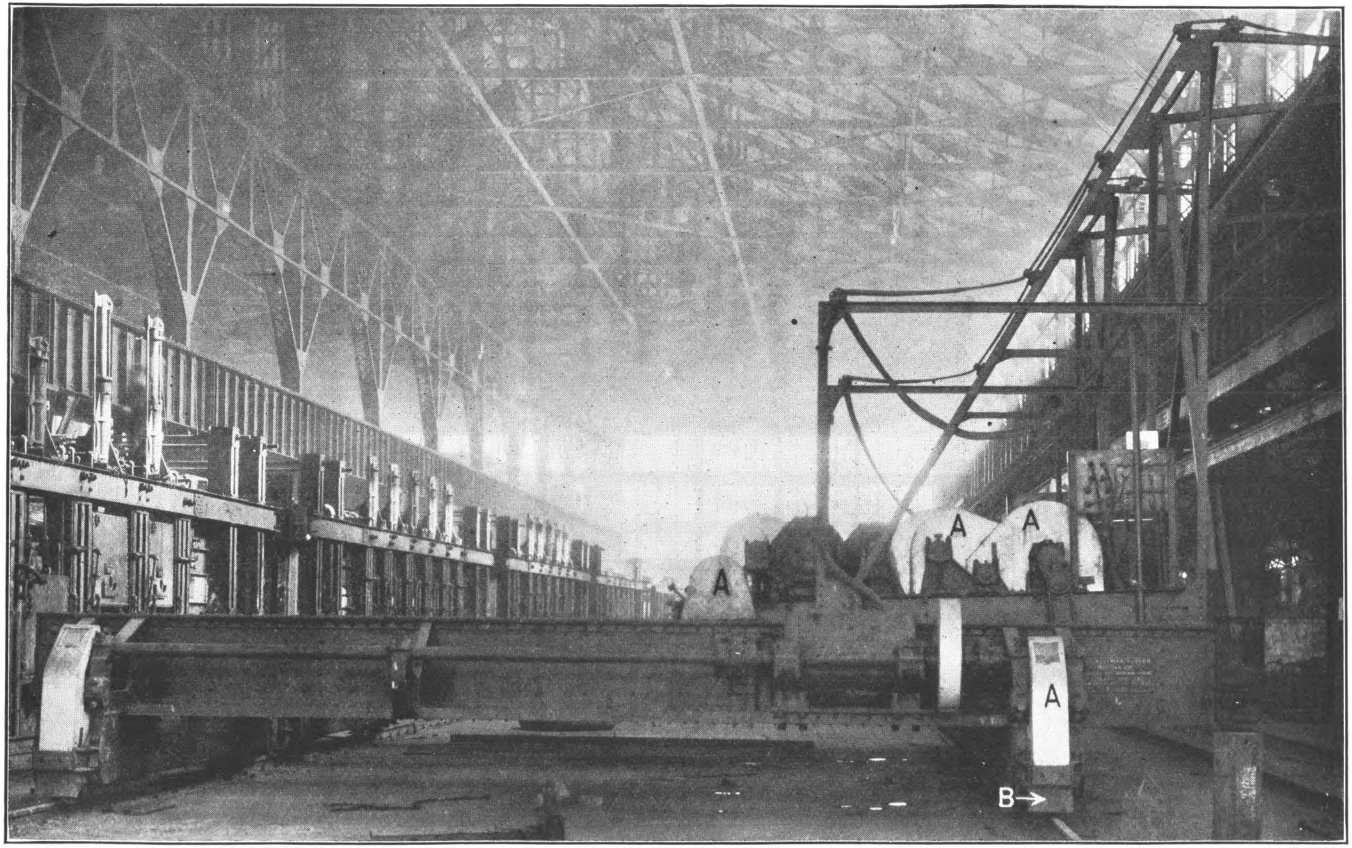


PLATE 10.—OPEN HEARTH CHARGING FLOOR, CHARGING CAR IN FOREGROUND.

temperature and a large amount of carbon monoxide. From the limestone of the "burden" is expelled carbon dioxide, leaving quicklime. This dioxide unites with a portion of the carbon and becomes monoxide. These hot gases and the carbon react upon the iron ore, taking from it its oxygen and reducing it to a metallic state. When the "zone of fusion" is reached both iron and lime are melted. The heavier molten iron sinks to the bottom of the hearth, the melted lime, or slag, floating on top. As the molten iron thus subsides it is brought into intracontact with the melted lime and chemical reactions occur by which various impurities which would impair the quality of the iron are taken from it and drawn off with the slag. Whenever the quantity of slag becomes sufficient it is drawn through the cinder notch, and at intervals, usually about four times every 24 hours, the iron is tapped off through the tapping hole.

With such ore as was originally used, this process went on with comparatively little trouble. The ore was of a granular character, or consisted of masses which would be crushed to a size which allowed a free passage of air through "the burden" in the furnace.

Two conditions arose at the same time, adding very greatly to the difficulties of the furnace men: (1) The great deposits of iron ore in Northern Minnesota were discovered. This ore has a greater iron content than almost any other and is also a powdery mass which can be handled with steam-shovels and grab buckets. (2) Coincident with this discovery of ore there arose a very great demand for iron and steel products.

With the granular ore mentioned above the heated gases had no difficulty in passing through "the burden" and bringing about the desired chemical reactions, but when the fine powder of the Mesaba ore was introduced into the furnace it produced a "burden" which was penetrated by the blast with more or less difficulty. It will be more readily understood how this condition brings about furnace slips and incidental difficulties of other kinds if a particular case be followed. Let it be supposed that a portion of the "burden" on one side of the furnace is especially impervious to the passage of heated gases. The result would be to deflect the gas stream toward the other side of the furnace. That portion of the "burden" from which the gas is thus diverted will begin to fall in temperature. Some of it being in a pasty condition and just ready to fuse will solidify and adhere to the furnace wall. Such an adhering portion of the "burden" is called by furnace men "a hang." Once started it is very likely gradually to extend, and may reach entirely across the furnace, constituting a "scaffold." It is obvious that this condition checks the downward movement of the material and disturbs all the internal processes of the furnace. Below such a "scaffold" the continued combustion of the coke removes the support. In order to restore the action of the furnace an extra load of material may be dumped into the top or the pressure of the air blast may be rapidly changed. As a result of such efforts the scaffold finally gives way.

It is a matter of some debate whether the mechanical effect of such a "slip" is sufficient to account for the results which have occurred. It seems probable, however, that under certain circumstances an explosive compound may be formed. It has been suggested that this condition comes about as follows: If an almost complete "scaffold" is formed the carbon below it may be entirely consumed. When the break comes a quantity of free oxygen may be suddenly mixed with the gases above the "scaffold" and with incandescent coke dust. This union may be so sudden as to constitute a veritable explosion. At all events, it was not an infrequent occurrence with the older types of furnace, after Mesaba ore came into use, that the top mechanism of the furnace would be blown completely off and the entire contents of the stack ejected. When this occurred in a furnace where men were employed as "top fillers," it might produce a serious casualty. Among the records of such cases accumulated in the course of this study are two, in one of which 14 men were killed and in the other 12. It is evident that methods reducing a hazard of this character must be of the greatest interest.

The solution of the problem, both from a production and a safety standpoint, comes down to the fundamentals of blast-furnace practice. The Mesaba ore is so rich in iron, so readily mined, and so easily transported that the furnace man must necessarily use it and develop his productive methods accordingly.

With some of the raw materials it is possible to modify their quality in various ways to the great advantage of production and, fortunately, at the same time of safety. For example, in modern by-product coke ovens, it is possible to produce a coke of a high degree of uniformity. The importance of this uniformity may be illustrated by the following case. For a considerable period the performance of a group of furnaces had been unsatisfactory. A normal quantity of flue dust from these furnaces was about two carloads per day. For a week or more they had ejected 10 carloads daily. For some time the superintendent was entirely baffled in the search for an explanation. He finally discovered that the coal used in the coke ovens was not crushed to a uniform degree of fineness. In handling any granular material the coarser particles tend to become aggregated, leaving the other portions formed of finer particles. In the case under consideration the result of this sorting was that a part of the coke was composed of finer material, which easily pulverized into a powder and would then pack between the other elements of the "burden," rendering it somewhat impervious to the blast. On the other hand, the coke composed of coarser particles was more readily inflammable and so gave rise to unequal heat. When the crushing process was properly modified the furnaces gradually returned to normal action. At another plant the screening apparatus at the coke ovens got out of order. As a result it was necessary to take coke for the furnaces direct from the cooling racks without removing the "breeze." A few hours' use of this unscreened coke produced serious hanging and slipping in the furnaces.

It is evident that the substitution of the "by-product" ovens for the "beehive" process should contribute to safety as well as production.

The limestone, used as a flux, may also be treated so as to lessen the likelihood of troublesome slipping. If the limestone is crushed too finely, it will tend, by the filling in of the ore and the "breeze" between the particles, to obstruct the blast. If, on the other hand, particles of too large a size are left they tend to descend into the lower levels of the furnace without becoming completely converted into lime. The result is that their conversion consumes heat at a point where it is needed for other purposes. Very often limestone dust is even more troublesome. It may, under some circumstances, produce what is called "a lime scaffold," which is very difficult to dislodge. The best practice, therefore, requires careful crushing of a selected limestone and that the product be screened so that the size of the particles is uniform.

The precautions specified above having been taken with regard to the physical condition of the coke and the limestone, the next step in safe practice concerns the conveying and placing of material in the furnace. As noted already, any material consisting of particles of different sizes tends, under manipulation, to undergo a sorting process. In the older types of furnace where from stock pile to furnace the material was handled manually by loading into barrows with shovel or fork, it was possible through instruction to the men doing the work to prevent this troublesome sorting. Hand-filled furnaces still continue in use and some new ones are still being erected because it is thus possible to avoid this troublesome sorting of the material

To produce by mechanical means a degree of uniformity in the "burden" equal to that secured in the old type hand-filled furnace has severely taxed the ingenuity of the blast-furnace constructors.

In the transit from stock pile to furnace there are five or six points at which this sorting of material is liable to occur: When material drops (1) from the bin into the car; (2) from the car to the skip; (3) from the skip to the hopper; (4) from the hopper to the little bell; (5) from the little bell to the large bell; (6) from the large bell to the stack. It should be explained that the top of the furnace is closed by two bell-shaped valves placed one above the other. This double valve renders it possible to keep the top of the furnace always closed and so to avoid the escaping of the gases.

The commonest method of combating the sorting tendency is by devices at the furnace top. For example, a considerable number of furnaces have been constructed with rotary tops. After a skip load is dumped such a top automatically revolves a certain distance. The loads are thus discharged from different positions into the stack, tending to provide a more uniform "burden." Other constructors have sought by varying the position of the skip when delivering its load and by varying the form of the hopper to secure a satisfactory mixture.

These illustrations serve to indicate the lines along which inventive genius has been at work in solving the problem of handling huge quantities of material and at the same time of securing reasonable uniformity in product.

It is evident that both structural revision and changed methods are involved in the results which have been attained.

GAS FLAMES.

Carbon monoxide, which is one of the gaseous products of the furnace process, is highly inflammable and when mixed with certain proportions of air becomes explosive.

When Table 20 is examined, it becomes evident that the severity rate for injuries due to the bursting forth of flames from different parts of the furnace was high in the early years (2.37 days per 1,000 hours' exposure in 1905 and 2.00 days in 1906). For several years thereafter the rates were low, but in 1911 there was a rate of 1.63 days.

These high rates in the early years are known to be related to the use of hand-filled furnaces. In them the material is carried up in an elevator to the level of the top of the furnace and the barrows are then wheeled by men, known as "top fillers," to the top of the stack and by them dumped into the hopper. The very large degree of replacement of this hand-filled process by mechanical devices is the main factor in the lessened severity rate from gas flames.

There have also been important improvements in the structure of the valves used in controlling the flow of the gas.

The development of gas washers has rendered the employment of the stove men and stove cleaners much less hazardous. In Plate 7 may be seen the large pipes called "downcomers" ("A") in which the gas from the top of the furnace is drawn off. This gas is heavily charged with flue dust, of which the coarser particles are removed in the "dust catcher" (see Plate 7, "B"). These dust catchers are nothing more than very much enlarged portions of the "downcomer" pipe. At the lower end they are funnel shape, and a valve at the bottom of the funnel permits the accumulated dust to be drawn off into cars. The finer particles of dust are carried on in the stream of gas, some of them settling in the gas mains and others being carried into the stoves. When this dust-laden gas is fed to the stoves, openings between the bricks with which the stove is filled become choked up and as a result the burning gas may be forced out at unexpected places, causing serious injury.

In modern practice the gas, instead of being sent directly to the stoves, is passed through a gas washer, in which, by means of water sprays and by causing the gas to bubble through layers of water, the dust is removed and clean gas sent on to the stove. By thus freeing the gas from obstructing material the operation of the stoves is made very much more efficient and the safety of the mill is materially conserved.

As noted above the gas when mixed with air in certain proportions becomes highly explosive. It did not happen that the group of furnaces upon whose experience the table is based had any serious explosions except in connection with furnace slips. Since these gas explosions constitute a serious hazard it is appropriate to illustrate them at this point.

In one plant a very peculiar explosion of this sort occurred. For some purpose the pressure of the blast was reduced, the engines slowing down but not stopping. It is difficult to understand how, under such circumstances, any gas could find its way into the air cylinders. However, it did penetrate, an explosive mixture was formed, it ignited, and the engine was badly wrecked, causing the death of two persons and injury to several others.

For a clear understanding of the engineering revision by which the danger of such an accident was lessened, if not entirely removed, it is necessary to give some further description of the engines and stoves. Blowing engines are of two types, steam engines and gas engines. They consist essentially of a huge air compressor whose plunger is driven by steam or gas. The air compressed by the action of the engines is delivered into a main from which there are two branches, one going directly to the furnace (the cold blast) and the other to the stoves (the hot blast). Under ordinary conditions the branch direct to the furnace is closed by a valve and the current of air goes entirely by way of the stove, from which it is conducted to the "bustle" pipe surrounding the furnace.

At the time of the explosion noted above the valve in the cold-blast pipe was closed by hand and in all probability the closure was imperfect. When the engine suddenly slowed down, the pressure in the main became somewhat less than that in the furnace and gas was drawn back into the air cylinders. To overcome the possibility of such an occurrence, valves have been designed for both the hot and cold blasts. They are so adjusted that they close immediately upon the lowering of pressure and would seem to constitute an effective barrier against the recurrence of such an explosion as that described.

A furnace was in the process of being dismantled for the purpose of relining. In the lower part of the furnace there still remained a small amount of burning material. The imperfect combustion incident to this condition gave rise to a sufficient amount of carbon monoxide so that when it mingled with the air above it formed an explosive mixture. Six men were carrying some part which had been removed from the furnace. In this process they had reached a position where the six were in direct line with the opening where the tuyere had been. Just at this stage an explosion occurred, driving a stream of flame directly along the line of men. Several were instantly killed, others so seriously burned that they died later, and only one of the gang finally recovered. Such a combination of circumstances as that related could hardly be expected to occur, but that it did occur gives very forcible emphasis to the danger attending the formation of such explosive mixtures. It is evident that under any circumstances a smoldering fire in a confined space may produce such a result. It has occurred rather frequently in the process of "blowing in" a furnace that the gases generated mingled with the air in the upper part of the stack and gave rise to explosions. It has become quite the standard practice to fill the space with some inert gas. The most readily available is live steam.

When from any cause the movement of gases through the mains is suspended, there will be a tendency to cooling and contraction. This might proceed so far as to give rise to a negative pressure. Since the mains are scarcely, if ever, absolutely gas tight, there would be a tendency at such times for air to filter into the mains, and it might do so in sufficient quantity to give an explosive mixture. One case has been observed in which an explosion due to this cause twisted a dust catcher into an unrecognizable mass.

Since nearly all furnace installations have at least two stacks, it is possible to provide junctions between the mains in such a way that there will be a constant gas supply and a regular pressure in the parts where cooling and the intake of air might otherwise occur.

With this precaution and with arrangements for the use of live steam at times, it should be possible practically to eliminate explosions of this character.

FALLING OBJECTS.

When we compare years of similar industrial character, as shown by Table 20, it will be found that in 1906 the frequency rate for falling objects was 21.40 cases per 1,000,000 hours' exposure and that 1913 shows 6.23 cases. This is a decline of 71 per cent. Between the same years the severity rates changed from 3.73 days to 0.03 day per 1,000 hours' exposure, a decline of 99 per cent.

The high rates shown by the earlier years were due to hazards in the matter of falling objects which the blast furnaces share with other departments. The characteristic features of the blast furnace, incident to the storage of iron ore, coke, and limestone were responsible for a very small portion of the accident rates quoted above, the storage of stock having been deprived of its most dangerous element through the substitution of mechanical for hand labor. For example, when ore was transferred from the stock pile to the furnace in handbarrows it would happen very often that removal of the ore from the bottom of the pile would cause the pile to cave in upon the men. At the present time in all the important plants this transferring is accomplished entirely by mechanical means. The men who control the apparatus are but little exposed.

FALLS OF WORKER.

Falls of the sort distinctive of blast-furnace operations, such as those into ore bins, are a very considerable number. Next to them come falls from the transfer and larry cars. Most falls, however, are of a character which might occur equally well in other departments, blast-furnace workers being especially liable to falls from structures. An inspection of Plate 7 will show that a furnace has many points where the worker is obliged to go and from which a fall would be serious. In the illustration the modern installation of stairways, railed walks, and permanent spars for attaching hoisting apparatus are very evident. The provision of such means of safe access and movement from point to point has contributed greatly to the reduction of accidents, since falls from the elevated parts of the furnace would necessarily mean either death or serious injury. It is therefore not unexpected to find that the severity rate for injuries of this kind has declined even more rapidly than the frequency rate.

HANDLING OBJECTS AND TOOLS.

Before Table 20 was made it was anticipated that the handling of pig iron might prove to be a somewhat serious source of injury. It became evident, however, that the injuries resulting in connection with this work were commonly of minor severity. It is true that in many plants the handling of pig iron has become almost entirely a mechanical process. The frequency rates in connection with the handling of material are among the highest and show a very definite decline over the period under consideration. In severity, however, the rates are among the lowest. That is, the handling of objects naturally produces a very considerable number of injuries, only a few of which are of a very serious character.

POWER VEHICLES.

There is in blast furnaces a varied sort of hazard from the necessary use of various forms of power vehicles. Very large quantities of raw material, ore, coke, and limestone must be brought into and moved about the plant. This calls for railway operations on a large scale. From the storage places the material must be moved to the furnaces, necessitating transfer cars and a number of small cars, called larry cars, which convey the stock to the furnace hoists.

The earlier years show, as might be expected, particularly high severity rates, such as, for example, 3.57 days per 1,000,000 hours' exposure in the year 1906. In the plants on whose experience this table is based there was an almost complete control of the power vehicle hazard before the end of the period. Those accidents occurring in the last three years shown were of such minor character that the severity rates are too small to be considered. This control of the vehicle hazard has involved an almost complete reorganization of the transportation facilities. Whereas formerly many tracks were at grade they are now carried upon trestles, clearances have been provided, and the entire system simplified and improved to a degree which will not be appreciated except by one familiar with both conditions.

The decline in frequency was from 1.60 in 1906 to 0.40 in 1913—75 per cent. Severity declined from 3.57 days to 0.004 day, a reduction of 99 per cent.

ASPHYXIATING GAS.[56]

This danger, while not exclusively one found about blast furnaces, is much more common and serious there than in any other industrial process. It is rather curious that the comparatively few cases of asphyxia from the gases given off by motor cars have attracted more attention than the frequently recurring deaths which were formerly characteristic of blast-furnace operations.

The frequency rates as shown by Table 20 are low as compared with other accident causes and the severity rates are high and do not decline in the marked degree exhibited by some of the others. Thus, the rate for the year 1914 (3.87 days per 1,000 hours' exposure) was as high as that for 1906 (3.83 days). Besides this serious direct action of asphyxiating gas, it contributes constantly to accidents commonly charged to other causes. For example, the severity of falls noted above is in part due to the fact that under the influence of the gas the men lose control of themselves and falls result.

The most important element in controlling the hazard of asphyxiating gas has been certain modifications in structure. Formerly the gas was carried in brick conduits underground. It was difficult, if not impossible, to render these conduits gas tight and often when damaged the fact would not be known unless the escaping of gas became very pronounced.

It is very commonly the case around furnaces that the ground has been built up by the use of porous waste material from the furnace itself.

When there was constant leakage into this porous ground of gas from the mains, the entire area became saturated so that gas was constantly being given off into the air in the vicinity. This continuous poisoning of the air could not fail to have its effect on the health of those working under such conditions; from time to time an accumulation of the gas would occur in some confined space and on entering it someone would be overcome and perhaps die as a result. In the present practice the mains, instead of being buried in the

[56] Technical Paper 106, United States Bureau of Mines, gives detailed instructions regarding the reduction of the hazard of asphyxiating gas.

ground, are carried at a considerable elevation overhead. They consist of well-riveted boiler plates, which may be made very nearly gas tight. These are lined with refractory brick to prevent the loss of heat. It is evident that such mains, located above the heads of the majority of the workers, would not, even if they gave off gas, pollute the air in the same way that the underground conduits did.

The lessened use of the hand-filled furnace has significance in connection with the reduction of cases of asphyxia. This may be illustrated by the following example: The bell of a hand-filled furnace had become overheated and warped, allowing the gas to escape. The direction of the wind was such as to drive the gas toward the hoist. As a result the men there employed were constantly being overcome. The foreman had nearly doubled his crew of men. Half of the men were placed in a position to avoid the gas and directed that whenever one of their comrades was overcome they should pull him into the fresh air and one take his place. Those who were so seriously affected as not promptly to regain consciousness were sent down on the hoist and others were brought up. Finally one of the men was overcome just as he was emptying his barrow load of ore onto the bell. He fell in the hopper and against the bell and was severely burned. The combined effect of the gas and the burn caused his death. In endeavoring to rescue him the foreman and five or six other men were overcome. At this stage the effort to keep the furnace operating was abandoned.

Some illustrations of the insidiousness of this poisoning may be offered. Horizontal mains will gradually become filled with dust. In a particular plant it was the custom to shut off the main from the furnace and to leave a series of manholes along the top open. In this way after a few hours the main would become, supposedly, so free from gas that a gang of shovelers might be sent in to remove the dust. The foreman of such a gang of shovelers went down into the main at one manhole and walked along to another without experiencing any discomfort. Believing that the gas was sufficiently removed from the main he sent in the shovelers and they began work. Apparently the gas was caught in the pores of the dust, and when that was disturbed by the shovels several men were overcome. In efforts to rescue the half dozen shovelers some 30 men went into the pipe. A majority of them, including the assistant superintendent, were affected in various degrees, many of them becoming completely unconscious. Perhaps due to the realization on the part of the superintendent of the hazard involved, as indicated by his own experience, it was arranged that the removal of flue dust from that particular main should thereafter be accomplished by a stream of water, making it unnecessary for men to enter the pipe for the purpose of cleaning it.

The extreme care which is necessary wherever carbon monoxide gas is liable to accumulate is illustrated by the following case: There was in a blast-furnace yard a small motor house. There was one door and a single window, and no other opening except a space where the shaft of the motor went through the wall. As a precaution, the superintendent had detailed two watchmen to that part of the plant. Two were detailed because of the fact that they were obliged to inspect some places where gas might have accumulated, and one of them was instructed to remain outside so as to be able to assist the other if in the course of their inspection he became affected. These two men sought shelter on a stormy night in the small motor house. They were found in the morning dead from gas. No one had suspected that this building was at all dangerous, but apparently at this time the direction of the wind was favorable to forcing the gas in around the motor shaft and a sufficient amount entered in that way to produce the fatal results.

It is now quite frequently the custom to provide oxygen breathing apparatus for a worker who must go into a locality where accumulation of gas is liable to occur. This apparatus is now made in small forms and should help materially in reducing the death rate about the furnaces. Gas masks have, since the war, been developed to a point where they form a reasonable protection against carbon monoxide.

UNCLASSIFIED CAUSES.

This group embraces the causes which did not seem to be sufficiently characteristic of the particular department to demand individual attention. The frequency rates are rather high, but the severity rates are so low that the importance of this group of causes is not considerable.

COMPARISON OF THE YEARS 1906 AND 1913.

Throughout the foregoing discussion the two years 1906 and 1913 have been selected for purposes of comparison because of their similarity in industrial conditions. It is now clearly established that the rise and fall of industrial activity are reflected in the corresponding rise and fall of industrial accident rates. In the absence of other factors this fluctuation will be in very exact relation to the fluctuation in the proportion of inexperienced men in the working force. The contrast between the two years is due to the presence of another factor, namely, organized effort at accident prevention. For convenience the figures regarding the two years are here brought together in a single table. Both frequency and severity are shown and the percentage of reduction from 1906 to 1913 is introduced.

TABLE 21.—COMPARISON OF ACCIDENT RATES IN BLAST FURNACES FOR YEARS OF SIMILAR INDUSTRIAL ACTIVITY, 1906 AND 1913, BY ACCIDENT CAUSES.

Accident cause.	Accident frequency rates (per 1,000,000 hours' exposure).		Per cent of reduction 1906 to 1913.	Accident severity rates (per 1,000 hours' exposure).		Per cent of reduction 1906 to 1913.
	1906	1913		1906	1913	
Working machines	2.1	0.8	62	1.8	(1)	99
Cranes and hoists	5.3	2.0	62	3.6	1.4	61
Hot substances	35.9	8.6	76	15.1	.4	98
Falling objects	21.4	6.2	71	3.7	.03	99
Falls of worker	7.9	2.6	67	1.9	1.4	25
Handling objects and tools	8.7	5.6	35	2.0	.2	89
Power vehicles	1.6	.4	75	3.6	(1)	99
Asphyxiating gas	7.4	.4	95	3.8	1.3	65
Total	90.3	26.6	72	35.6	4.8	87
Number of workers	*1,262*	*1,658*	....	*1,262*	*1,658*	....

[1] Less than 0.005.

OCCUPATIONS AND ACCIDENT CAUSES.

Thus far blast furnaces have been treated as a unit. It is obvious, however, that the degree of hazard is not the same for different occupations. For the purposes of the safety man it is desirable to be informed with regard to any occupational differences which may exist. The following table is introduced to show such differences and to afford some measure of their importance. It is exceedingly difficult satisfactorily to separate the working force into occupational groups. It must therefore be understood that the figures in this table and others of a similar character are simply as close an approximation to a precise classification as it is possible to make.

It was not possible to compute severity rates for the different cause groups by occupation.

TABLE 22.—ACCIDENT FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR BLAST FURNACES, 1905 TO 1919, BY OCCUPATIONS AND ACCIDENT CAUSES.

Accident cause.	Cast-house men.[1]	Common labor.	Mechanics.[2]	Stockers.[3]	Unclassified.[4]	All occupations.
Working machines	1.2	0.8	1.0	....	2.1	1.1
Cranes and hoists	3.7	3.2	3.6	2.3	.6	2.7
Hot and corrosive substances	67.1	21.0	6.7	6.4	14.2	19.3
Falling objects	14.5	19.9	8.6	14.3	6.3	13.1
Falls of worker	8.6	6.5	4.7	3.4	5.7	5.8
Handling objects and tools	16.9	12.6	6.1	4.1	4.1	8.9
Power vehicles	.2	2.0	.2	1.5	.7	1.0
Asphyxiating gas	2.0	2.4	2.1	1.9	2.9	2.4
Unclassified	12.5	12.4	8.9	17.7	9.5	11.2
Not reported	....	2.7	.7	.8	.3	1.3
Total	126.7	83.5	42.7	52.3	46.4	66.9
Number of workers	*1,357*	*4,930*	*3,670*	*886*	*3,006*	*13,849*

[1] Includes bar and clay men, cinder snappers, keepers and helpers, ladle men.
[2] Includes blacksmiths, boiler makers, bricklayers, carpenters, handy men, machinists, millwrights, painters, repair men, riggers, pipe fitters.
[3] Includes bottom fillers, cagers, dust men, larry men, skip hoist men, stockers, top fillers, weighers.
[4] Includes blowers, crane hookers, cranemen, engineers, foremen, lever men, loaders, oilers, pig-machine men, scrap men, stove cleaners, stove tenders, switchmen, washers, firemen, and others.

When the total rates for each occupation are considered it becomes evident that cast-house employees had very markedly the highest frequency (126.7 cases per 1,000,000 hours' exposure). Elsewhere it is shown (p. 38) that this group also had high severity. It is presumably true that both the high frequency and the high severity are due to the accidents involving hot substances. The frequency among cast-house men of accidents from that cause is 67.1 cases, nearly four times as high as the frequency from handling tools and objects (16.9 cases).

Common labor shows high rates whenever it is possible to isolate it from other occupations. This is true in the blast furnace as in other departments. The rate of 83.5 cases, while not so high as that to be found in some other departments, is of serious importance. As with cast-house men, their most serious hazard is connected with hot substances, their rate in that connection being 21.0 cases. The rate for falling objects (19.9 cases) is higher than that of any other occupation.

Blast-furnace mechanics did not show as high a rate (42.7 cases) as that found in the general mechanical department (62.5 cases), but their severity rate is considerably higher.

The importance of asphyxiating gas as a cause of injury in blast furnaces is emphasized by the fact that all the occupations suffered almost equally from this cause. The highest rate (2.9 cases) is found among unclassified workers. This will be understood when it is noted that the stove cleaners, stove tenders, and gas washers are included in the unclassified group.

STEEL WORKS AND FOUNDRIES.

ACCIDENT CAUSES IN OPEN HEARTHS.

The open-hearth department is at present the most important of the steel-making departments. The first great impetus to steel construction was afforded by the invention and introduction of the Bessemer process. In order to produce satisfactory steel by the Bessemer process ore of a certain quality is necessary. The quantity of such ore becoming steadily less caused serious deterioration in the quality of the steel. This was particularly noticeable in the case of rails, where the increasing size and weight of the trains demanded the utmost in durability and strength. As a result of this the open hearth has steadily gained, since its introduction, upon the earlier method. At the present time there is a tendency to combine the two methods, partial purification being made in the Bessemer converter, and the metal being then transferred to an open hearth for final purification.

Table 23 illustrates the course of events in the open-hearth department from 1907 to 1914. The cases listed are those which are especially characteristic of the open hearth. Those cases which are common to this department and others are grouped under the heading of "unclassified."

TABLE 23.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR OPEN HEARTHS, 1907 TO 1914, BY YEARS AND BY ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	1.6	0.5	1.0	1.1	0.7	0.5	0.3	0.4
Cranes and hoists	12.7	8.5	7.2	7.5	6.3	4.6	4.1	4.3
Hot substances:								
Breakouts	3.8	.8	2.2	1.1	.1	1.4	1.3	......
Sparks and splashes	5.8	5.5	4.9	2.8	4.9	5.3	3.0	4.7
Spills	.4	......	......	.1	......	......	......	......
Explosions other than ingot	2.8	.3	1.4	1.3	......	.4	1.5	......
Ingot explosions	1.8	1.3	1.7	.6	2.1	.9	1.0	.7
Gas flames	1.6	2.2	1.6	1.5	1.1	1.1	.7	.9
Unclassified	4.8	2.2	4.4	4.8	5.1	3.6	3.5	2.0
Total, hot substances	21.0	12.3	16.2	12.2	13.3	12.7	11.0	8.3
Handling objects and tools	15.1	7.8	11.8	11.1	8.2	8.4	7.7	7.5
Power vehicles	5.6	2.5	3.6	2.8	2.7	4.2	4.9	.8
Unclassified	48.5	36.0	37.0	29.2	19.8	21.9	22.5	16.9
Total	104.5	67.6	76.8	63.9	51.0	52.3	50.5	38.2
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	0.9	......	0.03	0.03	......	......	......	......
C anes and hoists	4.6	0.1	1.0	1.9	1.0	0.2	0.1	0.1
Hot substances:								
Breakouts	.1	......	.03	.03	......	.7	.03	......
Sparks and splashes	.1	.1	.1	.03	.1	.1	.1	.2
Spills	......	......	......	......	......	......	......	2.0
Explosions other than ingot	4.2	1.2	.1	.1	......	......	1.4	......
Ingot explosions	.03	.03	.1	.03	.1	.03	.1	......
Gas flames	......	.03	.9	......	......	......	.03	......
Unclassified	1.0	.03	.9	.1	.1	.1	.1	.1
Total, hot substances	5.4	1.4	1.2	.3	.3	.9	1.8	2.3
Handling objects and tools	.1	.1	.1	.3	.1	.1	.1	.2
Power vehicles	3.0	.1	.3	.1	1.0	1.2	1.7	.4
Unclassified	.4	.6	1.4	1.4	.3	1.0	4.4	.3
Total	14.4	2.3	4.0	4.0	2.7	3.4	8.1	3.3
Number of workers	*2,987*	*2,120*	*2,872*	*2,138*	*2,725*	*3,525*	*3,603*	*2,483*

Over the period covered by the table there is a marked decrease in the rates. Frequency declined from 104.5 cases per 1,000,000 hours' exposure in 1907 to 50.5 cases in 1913; severity from 14.4 days per 1,000 hours' exposure in 1907 to 8.1 days in 1913, the intermediate years being uniformly lower.

This decline was distributed over the individual cause groups but by no means regularly. This can be best brought out by consideration of the different causes.

WORKING MACHINES.

The characteristic machine of the open-hearth department is the charging car (Plate 10), by means of which the boxes containing the scrap are lifted from the cars and thrown into the furnace. Some of the older types of these cars had a considerable amount of uncovered gearing in which the operator could be caught. The machines are now made with the gears completely covered and also are provided with fenders covering the wheels, so that the hazard to the operator and those working about the machine has been materially reduced.

CRANES AND HOISTS.

The cranes used in open hearths are essentially like other overhead cranes but with certain modifications incident to the transportation of molten metal. The earlier type of open-hearth building had only room upon the large floor for the accommodation of the charging car. For this reason when hot metal was used in the furnace it was necessary to transport it overhead by means of a crane (Plate 11). This long distance transporting of ladles filled with hot metal introduced a very serious hazard for the men over whose heads the movement had to be made. In later construction the stocking floor has been made wider so that a ladle car can be moved lengthwise of the building behind the track on which the charging cars run.

When these ladles of metal reach a position opposite the furnace to be charged, the crane lifts them and carries them a comparatively short distance across the stocking floor.

On the other side of the furnace there is an area at a lower level called "the pit" (Plate 12). The present arrangement is not the pit in the original sense, but this name continues to be applied to it. The older types of open hearths had an excavation in which the ladles were lowered when the metal was to be drawn off from the furnaces. On this pit side the ladles receive the metals from the furnace and are carried across the pit to the far side where the molds, placed upon small cars, stand in readiness to receive the molten metal.

Two characteristic hazards may be noted in this region. While the ladle of metal is being moved a serious "spill" of the metal may be brought about by a break of the mechanism or from some other cause. If the movement is accomplished safely the metal is drawn from a valve in the bottom of the ladle directly into the molds. During this process explosions may occur which will scatter the metal for considerable distances, endangering those within range. These hazards have been met in two ways: (1) Greater strength and improved design of the crane and of the ladle and (2) better means of escape or protection, particularly for the crane operator who is very seriously endangered in case of a serious spill.

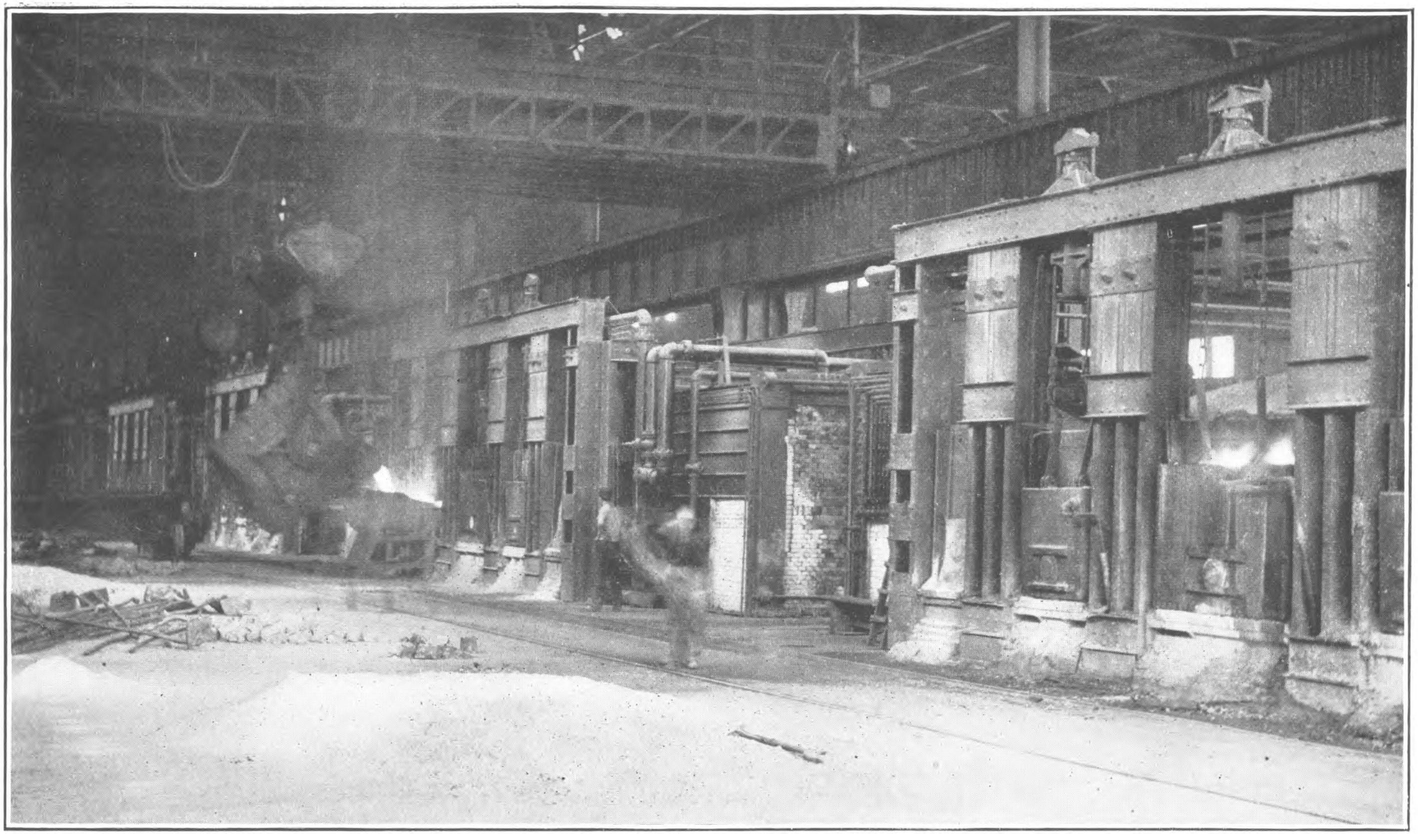


PLATE 11.—STOCKING SIDE OF OPEN HEARTH.

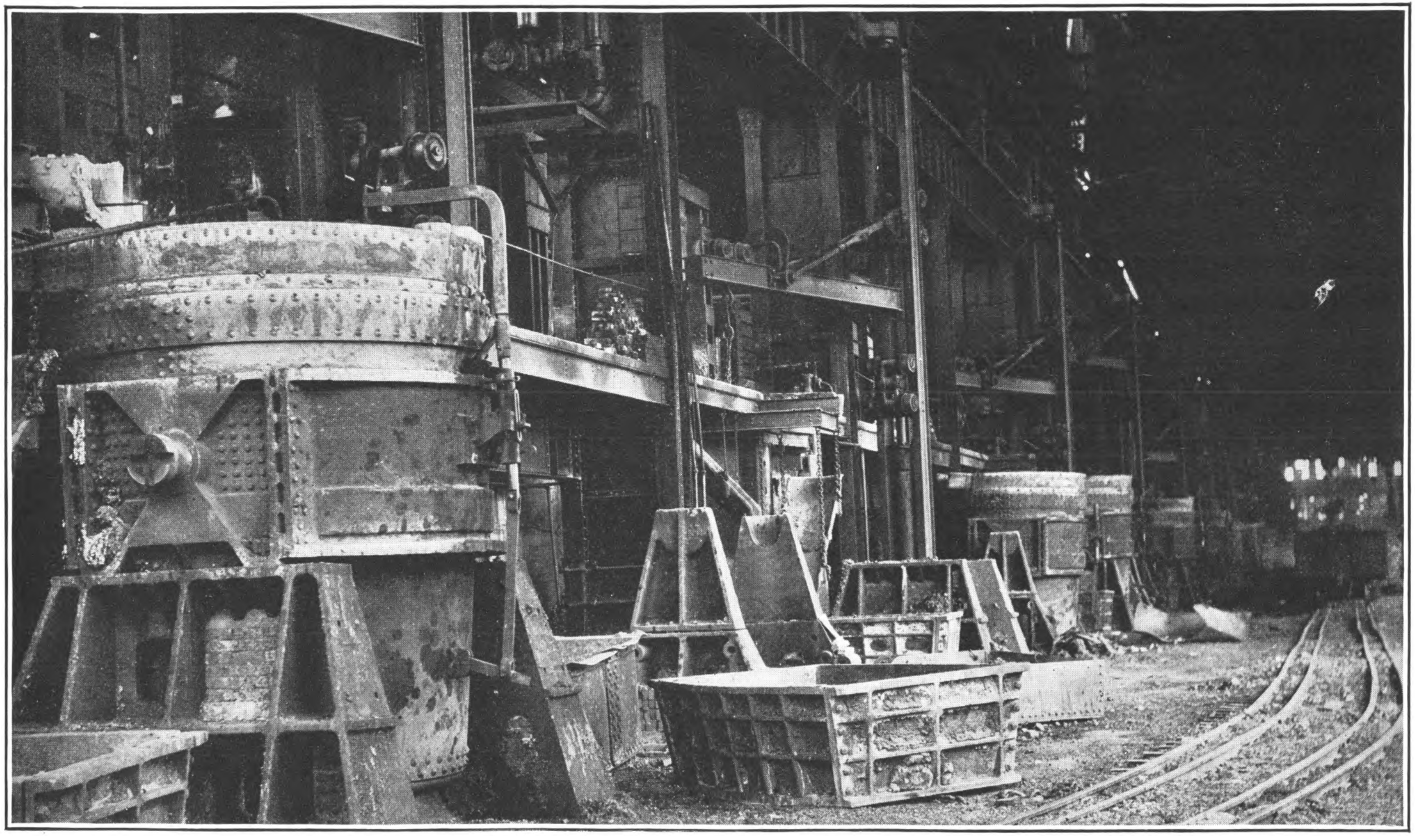


PLATE 12.—PIT SIDE OF OPEN HEARTH.

The structural changes involved in modifying the design of the ladle are too numerous to treat in detail but may be illustrated by one or two cases. The hooks by which the ladle was lifted were formerly cast in one piece. If these should break, they were apt to do so without warning, with disastrous results. It is common practice at the present time to build up laminated hooks by bolting together a number of steel plates. These are stronger than the older type of hook and also less liable to a complete break without warning. It has already been noted that for convenience in emptying ladles the points of suspension are not very much above the center of gravity. As a result, the overfilling of the ladle might raise the center of gravity nearly to or slightly above the point of suspension. In one open hearth the ladles which were in use were not quite large enough to take the entire heat from the furnace. Accordingly the superintendent had the upper edge of the ladle extended a few inches so as to accommodate the extra quantity. With the ordinary heat this operated without apparent danger. On one occasion, however, the amount of metal in the heat was in excess and filled the ladle almost to the rim. The ladle was raised and transported a few yards and then turned completely over. Several men were badly burned, one or more fatally. Two changes were made; the ladles were reconstructed so as to throw the center of gravity to a lower point and a latch was devised which would automatically fall into a groove and prevent the tipping of the ladle until it had been released.

Since the craneman performing his duties is in a position necessarily exposing him to grave danger in case of a spill, much ingenuity and money have been applied to affording him some means of escape. These are usually of two types: The closed chamber within the crane cage, lined with heat-resisting material, into which the craneman can readily pass in case of danger, and a railed gallery on the outside of the building, to which there is easy access through openings in the wall. Such a gallery had been constructed on one open hearth and for several years nothing occurred making its use necessary. The company had even considered removing it as a useless adjunct. Finally, one of the ladle hooks gave way and the contents of the ladle began to pour out along the floor. The craneman, without shutting off the power, escaped to the gallery; then, realizing that his crane was still in motion and that the spilling of the metal all the length of the building might have serious consequences, he rushed down the gallery, managed to climb again into his crane cage, shut off the power, and again escape. Fortunately, in this case there were no casualties but the opportunity for them was seriously present.

HOT SUBSTANCES.

Breakouts are of much less importance in the open hearth than in blast furnaces, but the accidents which from time to time occur from this cause may be exceedingly serious. It is often necessary to have a depression in front of the furnace to accommodate the very large ladles.

A large amount of material had accumulated in one such pit and two men were sent down into it to make a cleanup. The tapping hole of the furnace gave way just at this time and the men were covered with the white hot metal. As a result of this accident several plants have devised mechanical means by which the rubbish can be removed without the necessity of the men descending into the pit.

Minor injuries occur from time to time when the tapping hole is being opened, and it has not appeared feasible to adopt the same sort of screens which have been effectively used in the blast furnace. It is possible, however, for the men to safeguard their eyes by the use of appropriate goggles.

Table 23 shows that sparks and splashes cause a very considerable number of injuries in the open hearth. These are, however, of rather slight importance. The frequency rates for this cause declined slightly during the years covered by the table, from 5.8 cases per 1,000,000 hours' exposure in 1907 to 3.0 cases in 1913. The severity rates do not show a similar decline.

It has already been noted in connection with the operation of cranes that spills are an accompaniment of the transporting of molten metal. There is one other place where serious accidents of this kind may occur. This is at the mixer (Plate 13). This apparatus is of a bowl shape and capable of holding from 250 to 1,000 tons of molten metal. It is called a mixer because in this container the product of a number of different furnaces may be mixed, with the result that a more uniform quality of iron is delivered to the steel furnaces. The mixer is so constructed that it can be tilted to pour out the metal into the ladles which carry it to the furnaces. It is obvious that if the controlling mechanism fails a very serious spill on a large scale may take place.

Three methods have been applied to obviate this hazard: (1) Counterweights on the mixer, by which if control is lost the mixer is automatically restored to a horizontal position. A serious disadvantage of this method is that it adds very greatly to the dead weight of the mixer. (2) An electrically operated lock which fastens the mixer wherever it may be when the tilting apparatus acts improperly. (3) A safety valve in the hydraulic tilting apparatus.

It happened in one plant that the handle by which the operating valves were controlled broke. This, of course, left the operator entirely helpless and the mixer continued to tip until its entire contents were thrown upon the floor. As a result of this occurrence a safety valve was devised which has points of excellence making it worth a description.

The usual method of tilting the mixer is by means of two opposing cylinders which are operated by water pressure. These are designated as the pouring cylinder and the righting cylinder. The operator, by moving a lever, directs the water into one cylinder or the other according to the necessities of the case. The breaking of the handle in the case noted above necessarily rendered control by the operator impossible. The safety valve meets the difficulty in the following manner: A branch from the pipe supplying the pouring cylinder leads off to the sewer. In this branch is placed a valve counterweighted so that it will stand open. As long as it stands open no pressure can be directed into the pouring cylinder. Alongside the operator there is a small footplate on top of a rod projecting through the floor. When the operator wishes to pour he depresses this footplate by stepping upon it, the rod actuating the valve before mentioned. In case of emergency all that is necessary to stop the

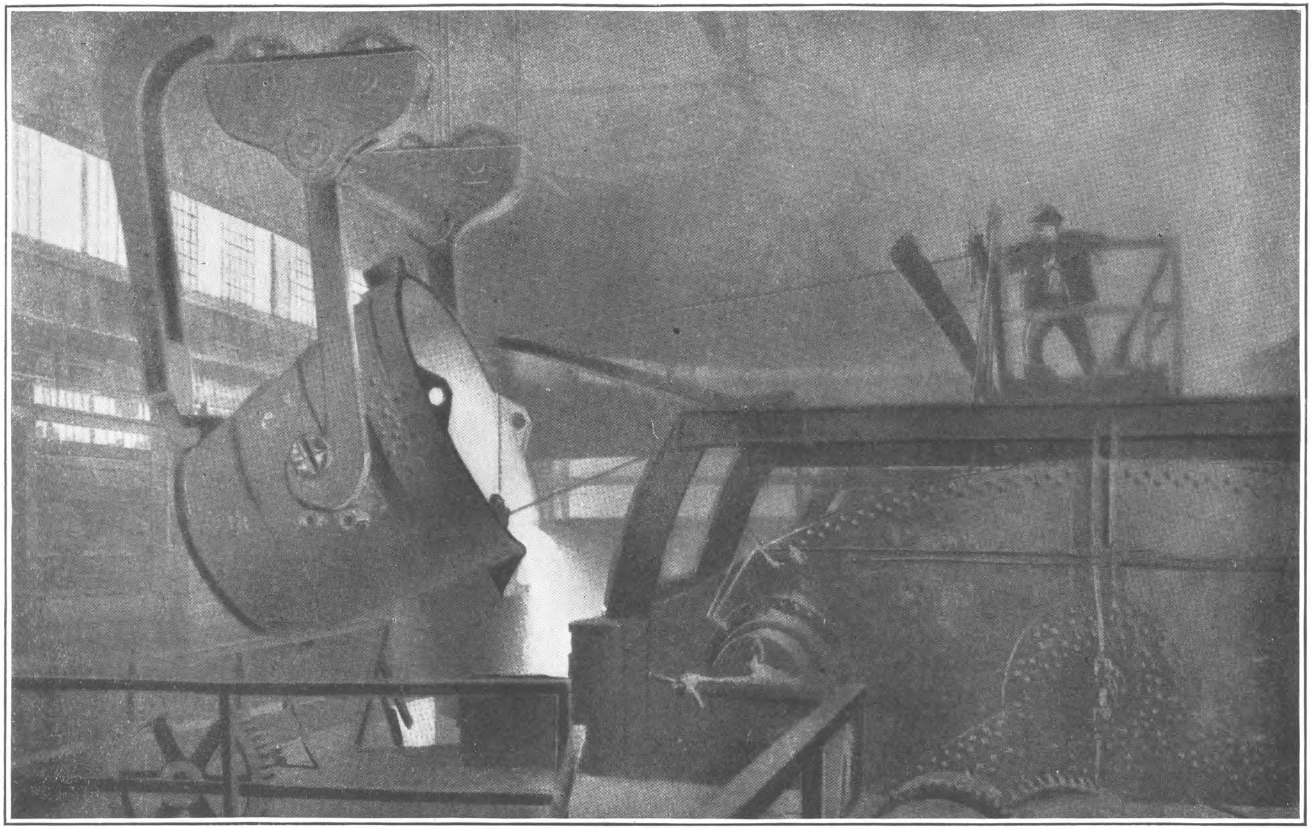


PLATE 13.—POURING MOLTEN IRON INTO MIXER,

tilting of the mixer is for the operator to remove his foot from the footplate. This allows the pressure to force the water into the sewer and the pouring cylinder ceases to act.

This device is an excellent one in several particulars: (1) Since it must be used in the regular operation of pouring it will necessarily be kept in good order; (2) while the operator controls its action, it is essentially automatic; (3) very slight action on the part of the operator brings it into play.

Among other forms of explosion, those occurring during the pouring of ingots have received considerable attention. Table 23 seems to indicate that, although of considerable frequency, such explosions are not very important from the standpoint of severity. The most frequent circumstance under which ingot explosions occur is when the cover is removed from the top of the mold. There are three ways to deal with this hazard: (1) The use of open-top molds; this causes a larger amount of waste from the ingot but not enough to offset the reduction in accidents; (2) handling of the molds in such a way as to prevent the removal of the cover until sufficient cooling has occurred to render explosion unlikely; (3) the installation of screens, from behind which the uncapper can work. Explosions other than ingot explosions are shown by the table to have constituted an extremely important cause of injury in the open-hearth department during the early years. In 1907 the frequency rate was 2.8 cases per 1,000,000 hours' exposure; in 1913 it was 1.5 cases. The drop in severity is from 4.2 days per 1,000 hours' exposure to 1.4 days. This is a decrease of 46 per cent in frequency and 66 per cent in severity. The notable lessening of severity is attributable almost entirely to improvement in structural method. In the nature of the case, the man employed has no control over the occurrence of an explosion.

Improvement in method is illustrated by the following case: In the production of special ingots of unusual size from which armor plate and other large forgings may be produced it is customary to fill the molds by what is called "bottom pouring." A tube leads down beside the mold to the bottom of a pit in which the mold stands. Metal pouring into this tube gradually rises in the mold from the bottom. Placed on top of the large mold is a smaller one held in place by guy rods which may be tightened by means of turn buckles. The crack between the two molds is carefully closed by a luting of clay. When the large mold is nearly full a small ladle of molten metal is brought by the crane and poured into the small mold from above, 15 or 20 minutes being taken to complete this process. On one occasion the small ladle had what is known as a "running stopper"; that is, a stopper that did not perfectly close the opening and allowed constant escaping of metal from the bottom of the ladle. Under these circumstances perfect control of the pouring process was impossible and the filling was hurried so that it was completed in about 5 minutes instead of the usual 20. When the small mold was nearly full a violent explosion occurred. The molten metal was forced out at the junction between the two molds in a sheet which entirely covered one of the men standing by. The exploding gases filled the space with flame to such an extent that the woodwork of the crane cage was set on fire. Several other men beside the one upon whom the molten metal fell inhaled the blazing gases, bringing on fatal attacks of pneumonia.

As the result of this severe accident, the engineering department gave serious attention to possible modifications of the method of procedure. The operation was moved to a deeper pit and such arrangements made that in case of a similar explosion the men would not be in range of the metal and burning gases.

Minor explosions in the slag and in the metal occur from time to time, against which the only precaution is that of proper clothing and the use of eye protectors. In the matter of operative procedure, waste material must be avoided, since in masses of this kind the conditions permitting explosions are apt to arise. Table 23 shows that the bursting out of flames from the furnace is a somewhat frequent cause of injury.

The man who suffers from these injuries is the one whose duties call him to the vicinity of the furnace, but he has practically no control over the conditions which involve him in hazard.

Among unclassified hot substances causing accidents, hot water and steam are the most important in the open hearth. The abatement of such accidents is a matter of improved structural and better operative methods.

HANDLING OBJECTS AND TOOLS.

High frequency and low severity are characteristic of this cause group in the open hearth as elsewhere. In 1907 the frequency rate was 15.1 cases per 1,000,000 hours' exposure; in 1913, 7.7 cases. The severity rates are identical in the two years (0.1 day per 1,000 hours' exposure). Accidents represented by such severity rates are evidently not of very great significance. The marked reduction in frequency, which is evidently due to decrease in minor injuries, is probably to be attributed to the use of magnets on the cranes for the handling of scrap. Had it been attempted to move the enormously increased quantity of material characteristic of recent operations by the old hand method such reduction in frequency would have been quite out of the question.

POWER VEHICLES.

In 1907 the frequency rate for power vehicles was 5.6 cases and in 1913, 4.9 cases. This is a reduction of only 12 per cent. Severity declined from 3 days to 1.7 days, a 43 per cent decrease. It is interesting to compare these rates with the corresponding rates for blast furnaces. Open hearths had much greater frequency in both years. In severity the rates were about the same in 1907, but very much higher for open hearths in 1913.

It is evident that the power vehicle hazard is distinctly greater in open hearths than in blast furnaces. For this there should be some discoverable reason. It would seem to lie in the fact that in the open hearth the transportation of materials goes into and through areas where other operations are being conducted. Such a condition is always conducive to accidents. In most of the departments the cars go to and from the mill without entering upon space so occupied. A few illustrations will emphasize the peculiar conditions of the open hearth. On the stocking floor hot-metal cars move from time to time along the track behind the charging cars. Into the storage space outside the hot-metal track railway cars bring the raw material. On the pit side of the furnaces cars are being constantly pushed in and out for the removal of slag and other refuse, and ingot trains are moving very frequently. In view of these intrusions of the transportation system into areas used also for other purposes it becomes of the highest importance that the equipment be in every way possible rendered safe and that the men to supervise it be most carefully selected.

UNCLASSIFIED CAUSES.

Very high frequency and relatively high severity are disclosed in this miscellaneous group. "Falls of worker" show considerable severity, but it can not be compared with that for blast furnaces. A considerable portion of the severity rate for this cause group in early years was due to the fact that adequate railed walkways for the conducting of overhead operations were not provided.

Heat exhaustion appears rather frequently in open hearths, as it does in plate and sheet mills. Two circumstances, however, modified this condition in the open hearths: (1) The introduction of water-cooled doors and door jambs on furnaces. Water circulates constantly through the hollow doors and jambs and very materially reduces the temperature in the vicinity. (2) The provision of an adequate supply of cool water for drinking. Formerly in these mills the operatives themselves secured ice and cooled the water. This drinking of ice water was injurious not only because of the introduction of an unduly chilling fluid into the stomach but chiefly because the use of very cold water leads to the taking of an insufficient amount. The man thinks that he has drunk sufficiently when all that has happened is that his stomach has been chilled into insensibility.

OCCUPATIONS AND ACCIDENT CAUSES.

Table 24 shows the cases in which it was possible to isolate occupational groups and determine the rates for various causes in the groups.

TABLE 24.—ACCIDENT FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR OPEN HEARTHS, 1905 TO 1914, BY OCCUPATIONS AND ACCIDENT CAUSES.

Accident cause.	Common labor.	Pit side workers.	Pouring platform workers.	Stocking floor workers.	Unclassified workers.	Total.
Working machines	1.4	0.2	....	0.5	1.2	0.7
Cranes and hoists	2.3	.8	....	.2	.6	.8
Hot substances	30.1	12.5	14.0	12.1	13.8	16.2
Falling objects	34.7	6.7	1.7	10.0	11.2	14.1
Falls of workers	.5	.2	....	.4	.9	.4
Handling tools and objects	4.9	.1	....	.7	8.3	3.1
Unclassified	82.0	11.0	9.4	14.5	23.0	28.8
Total	155.9	31.5	25.1	38.4	59.0	64.1

Common labor shows here, as almost everywhere else, the highest frequency. This might not be a matter of serious concern, since it is undoubtedly the case that the sort of work which a common laborer does exposes him to the chance of very numerous minor injuries.

Where it has been found possible to isolate the common laborer and determine the severity of his injuries, a uniformly high rate is found to prevail. The total rate for common labor in open hearths is 155.9 cases per 1,000,000 hours' exposure, more than twice that of the unclassified group, which stands next (59.0 cases). When the different causes are observed, it will be found that in the majority the common laborer shows the highest frequency rate. For handling tools and objects the unclassified group has a rate of 8.3 cases, while common labor has 4.9 cases. When it is noted that the unclassified group includes the mechanics, who are characteristically users of tools, the high frequency is in a measure explained. It is manifest from the showing in this department and in others that the closest study should be given to the conditions under which the common laborer works. Where the foreman has been induced by reward or other method to give attention to the selection and training of common laborers, the number of minor injuries has been greatly decreased. It is also true that constant and careful scrutiny of the working conditions has made possible modifications in that particular which have had a very favorable influence on severity.

ACCIDENT CAUSES IN THE BESSEMER DEPARTMENT.

The statements already made with regard to open hearths are applicable in a rather large number of cases to the Bessemer department. This section will therefore emphasize particularly those features of hazard which are peculiar to the Bessemer process.

Table 25 presents the frequency and severity rates in this department over a series of years. The amount of exposure is smaller than it should be to insure reasonably typical results. The severity rates are notably fluctuating and it is more than possible that this is due to the inadequate exposure. As a rule, rates have not been calculated where the number of workers falls below 1,000. An exception is made in the case of the Bessemer because it is still an important and characteristic steel-making method.

TABLE 25.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE BESSEMER DEPARTMENT, 1907 TO 1914, BY YEARS AND BY ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	1.4	1.3	....	0.4	1.0	....	0.8	0.6
Cranes and hoists	8.3	6.5	3.6	7.7	3.5	2.5	3.4	2.9
Hot substances	38.3	11.7	12.0	10.6	7.0	14.0	9.1	6.9
Handling tools and objects	4.6	11.1	8.4	13.6	6.5	2.1	6.5	1.7
Power vehicles	4.8	4.5	2.7	5.1	2.5	3.0	1.5	....
Unclassified	76.9	53.5	38.2	46.3	25.9	33.4	20.6	9.8
Total	134.3	88.6	64.9	83.7	46.4	55.0	41.9	21.9
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	0.03	0.03	....	(1)	....	(1)	0.01	0.1
Cranes and hoists	.2	9.2	0.03	0.2	0.1	0.1	.1	.5
Hot substances	1.1	.2	.2	6.1	.2	.2	.2	.2
Handling tools and objects	.1	.1	.1	.2	1.4	.03	.1	.5
Power vehicles	.1	.2	.1	.1	.1	.1	2.7	....
Unclassified	3.4	5.3	6.8	3.7	.3	.9	.3	4.6
Total	4.9	15.0	7.2	10.3	2.1	1.3	3.4	5.9
Number of workers	*967*	*511*	*750*	*784*	*669*	*788*	*875*	*576*

1 Less than 0.005.

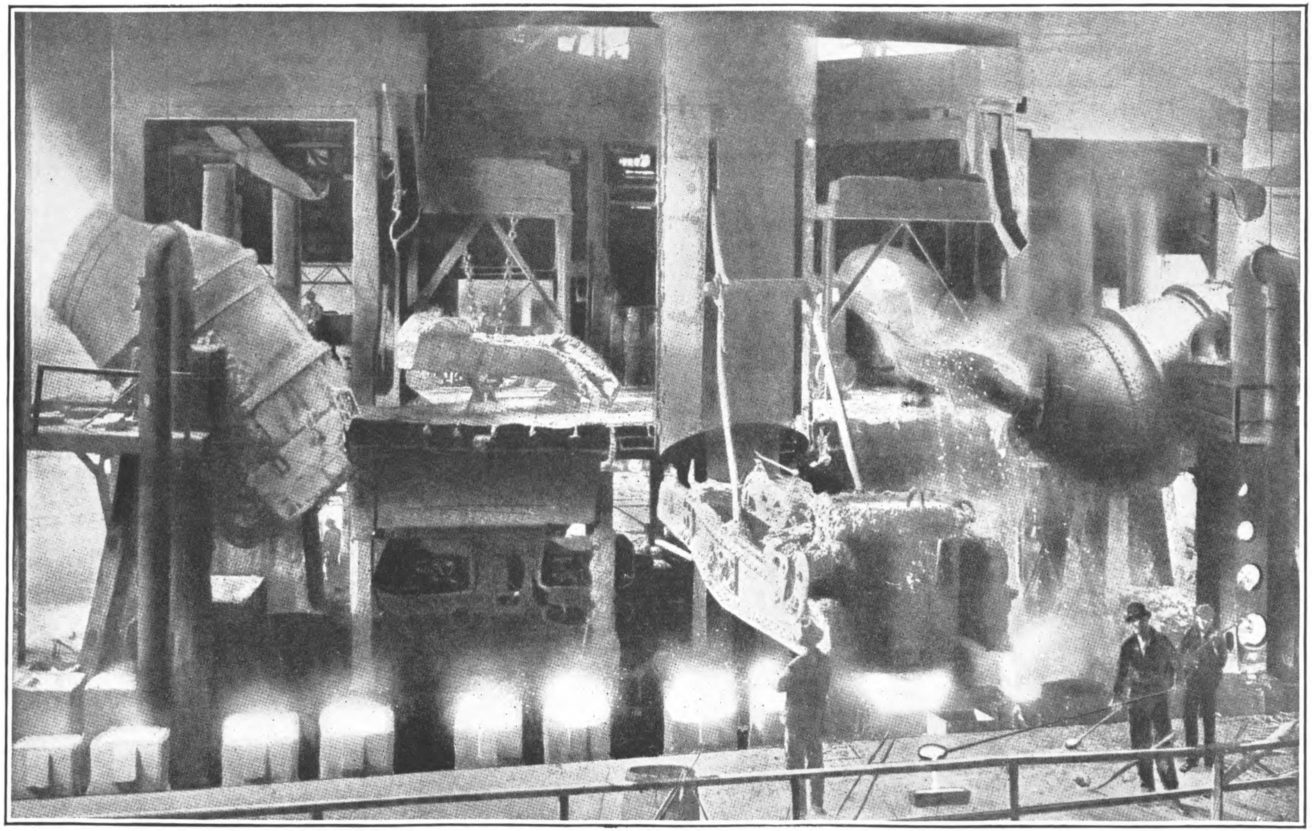


PLATE 14.—BESSEMER STEEL CONVERTERS.

There are, however, other reasons for irregularity than small exposure. Explosions and other unexpected events are of more likely occurrence in this department.

Working machines as a cause of accident are negligible in this department. The converting vessels might themselves be regarded as machines but the accidents connected with them are nearly all properly classified under other heads, such as hot substances, falling objects, etc. Cranes and hoists are here as elsewhere of high importance as accident causes, both in frequency and severity. In 1907 cranes show a frequency rate of 8.3 cases per 1,000,000 hours' exposure, declining in 1913 to 3.4 cases. Severity in the same years declined from 0.2 day per 1,000 hours' exposure to 0.1 day.

While hot substances constantly show high frequency rates during the period covered by Table 25, severity rates are high in only a few years. The high frequency rates are related to the fact that the air blown through the molten metal drives out from the converters a shower of sparks. Some of these are of sufficient size to burn a hole through ordinary clothing and injure the flesh beneath. The very high severity rate of 6.1 days shown in 1910 was due to a bad spill which caused two deaths.

A case has already been cited which indicates the considerable danger which may result from a "running stopper," that is a stopper that will not close the opening at the bottom of the ladle perfectly. In one Bessemer an arrangement was noted which proved quite effective in minimizing danger from this cause. Air hoists were installed above the pouring platform. Upon the completion of the pouring from a given ladle the stopper was hoisted out. It was then inspected and if it appeared in good condition it was allowed to remain suspended until the completion of another pouring and then restored to use. If the inspection indicated anything unsatisfactory in its condition, it was lowered to the platform and replaced by another stopper, kept constantly in reserve. This procedure has two advantages: (1) Inspection is made after each heat, and (2) the stopper, having an opportunity to cool between heats, will last longer than one in continuous service.

Formerly, just prior to tilting the converter to discharge the heat, scrap and pig iron were thrown into the converter from a platform placed near its mouth. The men whose duty it was to perform this operation were exposed to very severe heat. Also, the masses of metal which they threw were apt to glance off and fall to the floor below instead of into the vessel. The number of injuries arising from this source was considerable and the severity high. In the best recent construction "the scrappers" work behind a water-cooled screen, the material being delivered into a chute, which practically prevents it falling to the floor below.

ACCIDENT CAUSES IN FOUNDRIES.

In Table 26 it has been possible to include only those foundries associated with large steel plants. The exposure in the plants covered by this table is, as was noted in the case of the Bessemer department, very small. The rates as shown are, however, of considerable interest to foundry men.

TABLE 26.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR FOUNDRIES, 1907 TO 1914, BY YEARS, AND BY ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	2.5	0.9	2.0	2.2	0.8	2.5	1.0	1.7
Cranes and hoists	11.4	8.3	20.0	10.9	7.6	15.8	6.4	9.1
Hot substances	14.2	12.1	13.2	11.8	9.1	7.9	8.1	3.4
Handling tools and objects	17.4	18.5	18.3	16.5	20.6	20.5	14.5	12.0
Power vehicles			.7	.3		.3	.7	.6
Unclassified	18.1	16.2	23.7	32.0	23.6	27.5	19.2	16.0
Total	63.6	56.0	77.9	73.7	61.7	74.5	49.8	42.8
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	0.1	(1)	0.03	(1)	0.1	0.2	(1)	(1)
Cranes and hoists	.2	0.2	.5	0.3	3.1	5.5	0.1	0.1
Hot substances	.2	.2	.3	.2	.1	.4	2.7	.1
Handling tools and objects	.2	.1	.1	.1	.6	.2	.4	.7
Power vehicles			(1)	(1)		(1)	(1)	.03
Unclassified	3.1	.2	.6	.6	3.3	.3	.3	.1
Total	3.8	.7	1.5	1.2	7.2	6.6	3.5	1.0
Number of workers	*939*	*719*	*985*	*1,189*	*875*	*1,056*	*990*	*585*

[1] Less than 0.005.

ROLLING MILLS.

HEAVY ROLLING MILLS.

Table 27 shows accident frequency and severity in heavy rolling mills for the period 1907 to 1914. On inspection of this table an interesting fact appears with regard to the unclassified group. This group includes those general cases which rolling mills share in common with other departments. It contributes more than one-half of the total frequency rate in each of the years. But in the case of severity this situation is reversed. The unclassified group contributes the minor part of the total rate in most of the years and in the later years very much smaller portions.

The tendency to decline in rates shown in the departments already considered is repeated in these rolling mills. Each of the cause groups shows a frequency rate noticeably lower in 1913 than in 1907. This is also true of the severity rates, with the exception of the "hot substances" group, for which the rate was only 0.6 day per 1,000 hours' exposure in 1907, 1.4 days in 1913, and 0.8 day in 1914. This would appear to indicate that hot substances were becoming a more serious hazard in mills of this type. It would be unsafe, however, to draw this conclusion from a single group of mills, even with an exposure as extensive as that here shown.

Apparently the rolls themselves gave rise to the most numerous accidents during this period and the number occurring has not changed materially in recent years. Objects flying from machines have declined in the frequency with which they caused injury. Accessory machines used about the mills give rise to a greater number of accidents than do the characteristic machines, but the severity is materially greater in the case of machines found only in the rolling mills.

TABLE 27.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR HEAVY ROLLING MILLS, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	5.6	4.0	4.4	3.3	3.8	2.7	3.1	2.4
Charging cranes	.1			.1		.1		.1
Roll tables	.1		.1	.1			.1	.3
Rolls	7.0	1.0	.6	.3	1.0	.8	.8	8
Transfer tables	.1	.2						.1
Hot beds	.3	.2	.2	.1			.1	.1
Shears	.4	.1	.2	.1	.2	.3		.1
Straighteners	.3	.5	.6	.3	.2	.1	.1	
Objects flying	3.0	1.3	1.1	.5	.6	.1	.3	.3
Other machines	2.7	.7	1.7	1.8	1.7	1.2	1.7	.7
Cranes and hoists	6.3	4.8	7.2	4.2	4.4	2.9	2.0	2.1
Hot substances	5.3	4.0	4.8	4.0	3.4	3.7	3.0	2.5
Metal in rolls	.3	.3	.1		.2		.1	.2
Leak	.5	.5	.7	.1	.3	.4	.5	.5
Other hot substances	4.5	3.1	4.0	3.8	2.9	3.4	2.4	1.8
Power vehicles	1.7	.7	2.0	1.3	1.0	1.1	1.1	.3
Unclassified	46.4	43.5	43.2	34.3	33.9	33.9	24.0	11.8
Total	65.3	57.0	61.6	47.1	46.5	44.3	33.2	19.1
	Accident severity rates (per 1,000 hours' exposure.)							
Working machines	0.7	0.9	0.7	1.2	0.4	0.1	0.1	0.1
Cranes and hoists	1.7	.1	1.3	.2	.8	.1	.03	.1
Hot substances	.6	.1	1.2	.5	.6	.6	1.4	.8
Power vehicles	.03	.03	.1	.1	.03	.1	.03	.1
Unclassified	2.2	1.7	1.8	2.2	2.1	.7	.4	.4
Total	5.2	2.8	5.1	4.3	3.9	1.6	2.0	1.5
Number of workers	*4,556*	*3,135*	*4,210*	*4,886*	*4,195*	*5,226*	*5,287*	*3,504*

Injuries due to hot substances happen almost exclusively either in the transporting of the material to the rolls or in its removal from them. This is naturally the case since the operations during the rolling are almost exclusively mechanical, while in the transporting of material it is frequently necessary for the men to supplement the machines by the use of hooks and bars.

The injuries occurring in this department are distributed with such a degree of uniformity that there is indicated no special line of effort which may be expected to yield conspicuous results. The continuous application of engineering improvement and modification in methods of procedure would appear to be the most promising form of effort.

The transfer tables of heavy rolling mills have on the shaft of each roll a large gear. As formerly constructed these gears were entirely uncovered, and from time to time a workman would lose a foot by stepping into them. In practically all cases guards have been attached to the various forms of transfer tables, completely covering these gears (Plate 15). Since attention has been drawn to their hazard the redesigning of such equipment has included the provision of inclosures for these gears. A very common form now used is a trough-shaped reservoir placed below the gear and partly filled with oil, so that the revolving gears are partially immersed in the oil. The cast-iron cover, which is readily removed in case of needed repairs, forms with the trough mentioned above a complete inclosure. The arrangement by which the gears revolve while partially immersed in oil renders attention to them, in the matter of lubrication, necessary only at considerable intervals. It is probable that the arrangement described very materially prolongs the life of the gears, and this, together with the lessened hazard, much more than offsets the extra time involved in the removal of the covers for inspection of which some mill men have complained.

In the older mills no provision was made for getting from one side of the transfer tables to the other, except by climbing and walking upon them. The open gears before mentioned and the moving material constituted a grave hazard for the experienced man, and the inexperienced man who attempted such a transit took his life in his hands. In all recent construction and in a majority of the older mills railed bridges over the transfer tables have been installed at reasonable intervals so that the men may pass from side to side without danger. Such opportunities might still be increased in some mills with advantage.

TUBE MILLS.

The rates from 1907 to 1914 for tube mills are shown in Table 28, and furnish a very striking illustration of the fundamental weakness of the frequency rate as a measure of hazard. A tube mill is organized for the carrying on of two processes: (1) The rolling of the tubes, which involves, of course, the various hazards of hot and moving material; (2) the finishing of the tubes, in which the apparatus used is essentially that of the machine shop. By means of it the tubes are cut into appropriate lengths, the ends are threaded, and other operations of a similar character are performed. Consequently minor accidents, such as cuts on the hands due to roughness on the threaded edges of the pipes, are of rather frequent occurrence.

TABLE 28.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR TUBE MILLS, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914	1907–1910	1911–1914
	Accident frequency rates (per 1,000,000 hours' exposure).									
Working machines	16.3	14.9	14.5	10.6	11.8	6.6	3.5	0.9	14.1	5.8
Cranes and hoists	7.6	4.1	5.3	4.5	3.1	2.3	1.7	1.1	5.5	2.1
Hot substances	14.1	6.9	7.7	6.0	8.2	5.0	1.6	1.7	8.9	4.1
Power vehicles	.2	....	.4	....	....	....	....	....	.1	....
Unclassified	58.1	46.4	56.8	55.1	52.2	42.2	19.4	11.4	54.6	31.7
Total	96.3	72.3	84.7	76.2	75.3	56.1	26.2	15.1	83.2	43.7
	Accident severity rates (per 1,000 hours' exposure).									
Working machines	0.5	0.3	2.3	1.7	0.2	1.6	0.1	0.1	1.2	0.5
Cranes and hoists	.1	.1	.1	.1	.03	1.2	.03	.2	.1	.4
Hot substances	.2	.1	.1	.1	.1	.03	.1	....	.1	.1
Power vehicles	....	....	.03	....	....	....	....	....	....	....
Unclassified	2.1	.8	1.1	.9	.8	.5	2.9	.7	1.3	1.3
Total	2.9	1.3	3.6	2.8	1.1	3.3	3.1	1.0	2.7	2.3
Number of workers	*2,007*	*1,451*	*1,813*	*1,792*	*1,717*	*2,131*	*2,101*	*1,527*	*7,063*	*7,476*

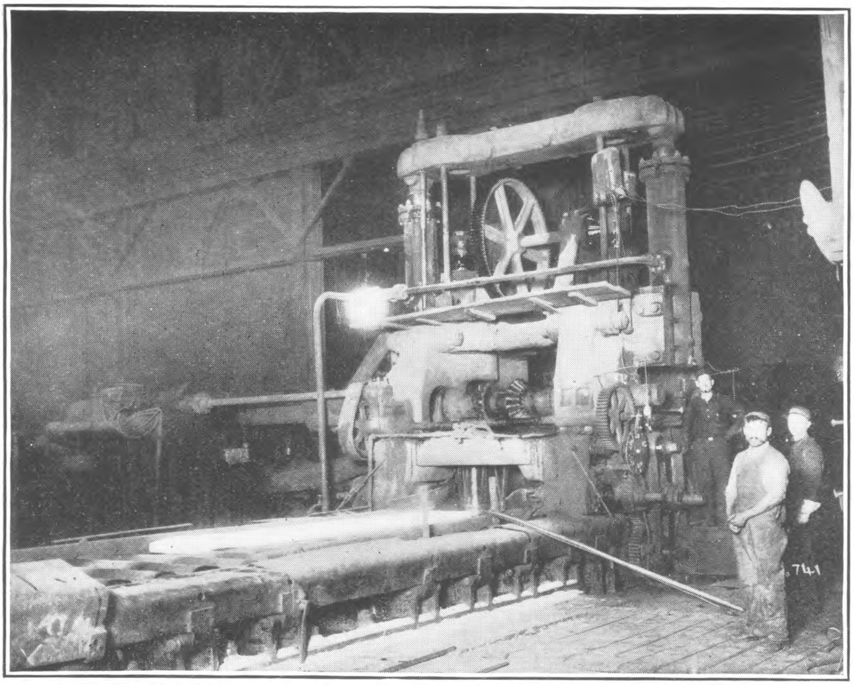


PLATE 15.—TRANSFER TABLES OF HEAVY ROLLING MILLS, SHOWING GUARD COVERING GEARS.

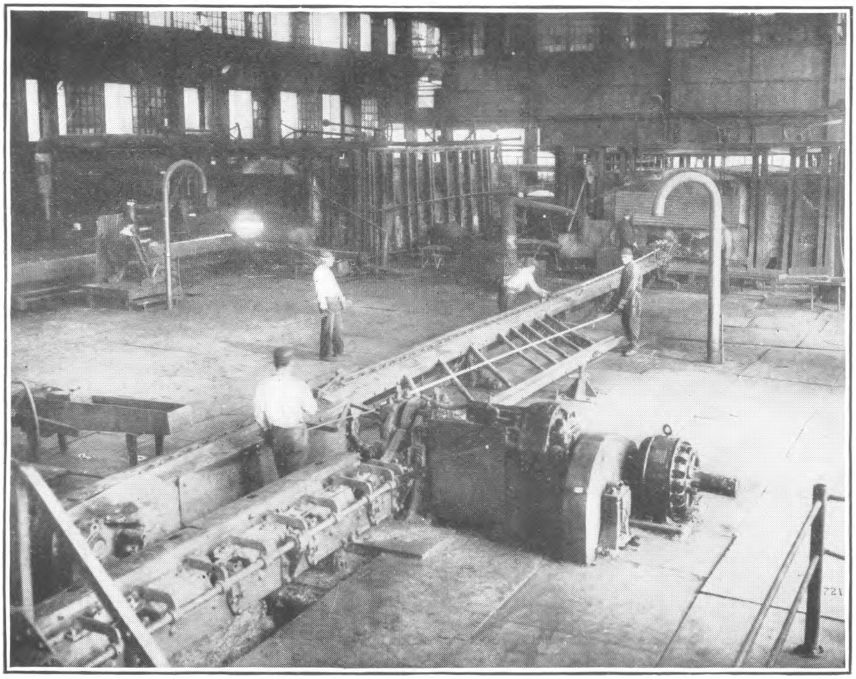


PLATE 16.—BUTT-WELD TUBE MILL.

On examining Table 28 it appears that the earlier years show notably high frequency rates but rather low severity rates. From time to time over the period covered the frequency rates decline and toward the last of the period with extraordinary rapidity. At the same time severity rates fluctuate with scarcely detectable decline. The only way in which the decline can be demonstrated is by dividing the interval into two 4-year periods. The result of this arrangement is shown in the last two columns of the table. In accidents from the operations of working machines there was a decline of 59 per cent (from 14.1 to 5.8 cases per 1,000,000 hours' exposure) from the earlier to the later period. At the same time severity rates declined 58 per cent (from 1.2 days to 0.5 day per 1,000 hours' exposure). In the case of working machines the trend of frequency and severity rates was very similar. Contrasted with this was the experience with regard to cranes and hoists. Frequency rates declined 62 per cent (from 5.5 cases to 2.1 cases) but severity rates rose from 0.1 to 0.4 day. This rise in severity rates is clearly due to some exceptional circumstances and might not be regarded as significant were it not for the fact that repeatedly in other connections a rise in severity rates and a falling in frequency rates have been found to be the case in tube mills.

Accidents from hot substances declined in frequency 54 per cent (from 8.9 cases to 4.1 cases), while in severity there was no apparent change. The accident frequency rates for the unclassified group of causes declined 42 per cent (from 54.6 to 31.7 cases), but the severity rates remained unchanged (1.3 days).

On examining the table a decline of 47 per cent in frequency rates appears (from 83.2 to 43.7 cases). The total severity rates show a decline of 15 per cent (from 2.7 to 2.3 days).

This group, divided into two 4-year periods, shows very clearly that influences were at work which brought about a definite decline in the second period as compared with the first. It is quite clear that judgments founded upon the frequency rate alone would give a distinctly wrong impression regarding the nature and extent of the improvements.

A detailed analysis of the accidents from working machines shows that in tube mills the pipe threading and pipe cutting machines contribute the largest number of injuries. These are, however, less severe than those arising from other causes, such, for example, as the "pushers" by which the material is forced into the furnaces.

CAUSES AND OCCUPATIONS.

In the case of a few important occupational groups in these mills it has been possible to compute rates for the different cause groups. These are shown in the following table. Severity rates could not be conveniently computed. Common labor occupies in these mills the same position in respect to frequency of accident that has been noted before. The frequency rate is 220.5 cases per 1,000,000 hours' exposure as against 57.6 cases for miscellaneous occupations. This unfortunate preeminence of the common laborer is found in each of the cause groups in which it was possible to isolate such workers.

TABLE 29.—ACCIDENT FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR TUBE MILLS, 1907 TO 1914, BY ACCIDENT CAUSES AND OCCUPATIONS.

Accident cause.	Common labor.	Furnace crews.	Finishing crews.	Miscellaneous occupations.	Total.
Working machines	20.6	4.2	5.8	11.9	9.8
Cranes and hoists	18.7	.5	.1	2.6	3.8
Hot substances	23.2	4.6	.2	5.6	6.4
Power vehicles	.2			.1	.1
Unclassified	157.8	10.8	14.1	37.4	42 9
Total	220.5	20.1	20.2	57.6	63.0

As already noted, the crews which operate the finishing machines show a rather high frequency rate.

PLATE AND SKELP MILLS.

Table 30 gives the distribution of accidents in plate mills, by years and accident cause groups. Comparing the years 1907 and 1913, "working machines" show a decline in frequency of 53 per cent (from 7.0 to 3.3 cases per 1,000,000 hours' exposure) and in severity of 45 per cent (from 2.2 to 1.2 days per 1,000 hours' exposure). Between the same years "cranes and hoists" declined 56 per cent in frequency (from 13.6 to 6.0 cases) but the severity rose (from 0.3 day to 1.5 days). Should, however, the rates for cranes and hoists for the two 4-year periods be compared, the later four years will show a lessened severity. "Hot substances" have a lower rate in 1913 than in 1907—in frequency 21 per cent (from 7.0 to 5.5 cases); in severity 98 per cent (from 4.2 days to 0.1 day). "Power vehicles" do not change materially in frequency but the severity in 1913 is higher than in 1907. The rates by four-year periods are about the same.

TABLE 30.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR PLATE MILLS, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	7.0	5.7	4.3	4.8	4.9	3.8	3.3	1.5
Cranes and hoists	13.6	6.5	10.8	11.6	7.1	9.7	6.0	3.4
Hot substances	7.0	5.7	6.7	5.3	4.7	5.5	5.5	2.4
Power vehicles	1.7	.6	2.2	1.8	1.2	1.8	1.7	.2
Unclassified	84.4	58.2	60.2	49.1	45.0	55.2	43.4	22.0
Total	113.7	76.7	84.2	72.6	62.9	76.0	59.9	29.5
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	2.2	0.1	0.1	0.3	0.1	0.5	0.2	0.03
Cranes and hoists	.3	.2	1.8	3.1	.1	.3	1.5	.1
Hot substances	4.2	.1	.1	.1	.1	.1	.1	.03
Power vehicles	.1		.03	1.5	.03	.03	1.4	
Unclassified	2.3	2.9	.7	1.1	1.1	2.2	.6	.5
Total	9.1	3.3	2.7	6.1	1.4	3.1	3.8	.7
Number of workers	*1,915*	*1,173*	*1,634*	*1,872*	*1,645*	*1,992*	*2,013*	*1,379*

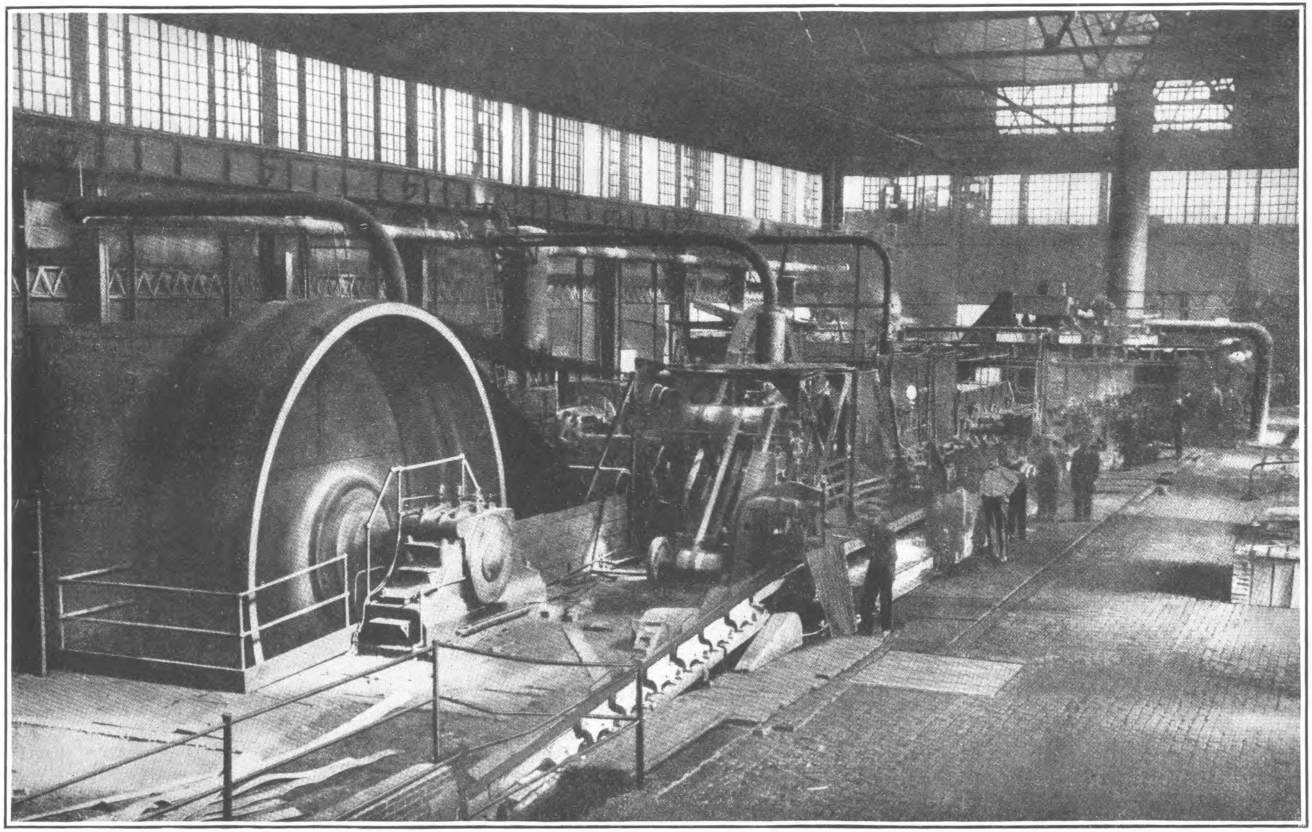


PLATE 17.—SECTION OF SKELP MILL.

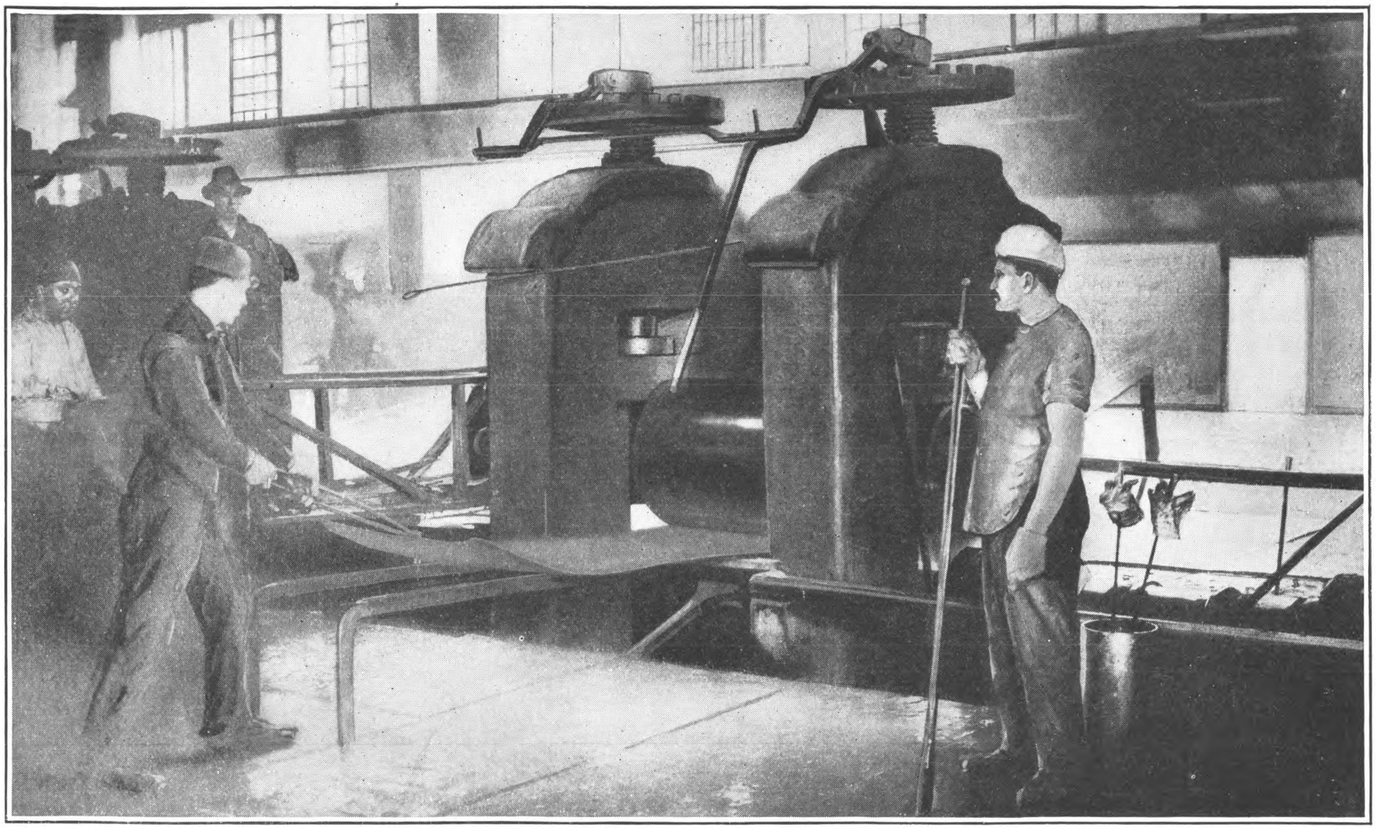


PLATE 18.—SHEET MILL.

There are two fields in which the study of plate-mill conditions ought to bring about a still further improved condition. The first is the operation of shears. The present method of handling plates through the shears gives rise to a considerable number of accidents. The method consists essentially in rolling the plate over a group of reversed casters. These adjust themselves to movement of the plate in any direction and quite frequently the plate overbalances and falls from the casters. It would seem to be possible for mechanical ingenuity to devise some method of handling the plates which would more or less obviate this danger.

The second field in which improvement has taken place and ought undoubtedly to go still further is that of protection of the operatives against heat exhaustion. Because of the extended area over which radiation may take place in the case of plates the temperature conditions for some of the men are exceedingly trying. Two safeguards should be applied to a greater extent than has yet been done. The more important of these is the supplying of water of good quality and of a temperature low enough to be palatable, though not so low as to discourage adequate consumption. The second safeguard is such an arrangement of the rolls and the roll tables that men will be exposed as little as possible to direct radiation and that in some cases a draft of air be provided by which the heat given off by the plates will be carried away from the operatives. In one mill in the course of repairs a complete rearrangement was accomplished, so that the operative was shifted to a position much less exposed than his original position and an electric blower was so placed that the resulting movement of the air passed the man, thence over the plate, and finally out through an opening in the side of the mill. Under the original conditions a number of men had suffered collapse from the effects of the heat. Since the rearrangement no cases of this kind have occurred.

SHEET MILLS.

Table 31 presents, by causes, for sheet mills the accident rates for frequency and severity. The frequency and severity rates shown in this table are both relatively low. As a whole they present a distinctly unusual condition. Frequency rates on the whole tend to rise while the severity rates are declining. In Table 32 the working force is divided into the hot mill crews and the other employees. The frequency rate of the hot mill crews is almost the same as that of the other employees. The hot mill men suffer their injuries very largely in connection with the characteristic machines of the mills. The miscellaneous employees are the sufferers from the group of causes called the unclassified. If, therefore, the experience for working machines and unclassified causes be compared, a fair idea will be given of the trend of events in the two occupational groups.

The rates given in Table 31 show that the accident rates for working machines (operated by the hot mill crew) exhibit during the entire period a definite tendency to rise, both in frequency and in severity. At the same time the rates for the unclassified group of causes, contributed for the most part by the miscellaneous employees, go down just as definitely.

TABLE 31.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR SHEET MILLS, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	4.4	5.3	3.7	4.3	6.4	5.9	6.6	6.1
Hot substances	7.2	3.8	2.8	1.6	1.5	2.5	1.0	2.1
Handling tools and objects	13.1	12.6	10.6	4.7	10.3	18.6	12.5	6.1
Heat	....	....	.6	.9	1.2	.3	.2	.5
Unclassified	20.1	18.5	16.5	12.6	16.9	21.8	17.8	16.1
Total	44.8	40.2	34.2	24.1	36.3	49.1	38.1	30.9
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	0.1	0.1	1.2	0.4	1.1	0.5	0.8	0.2
Hot substances	.1	.03	.03	.03	.03	.03	.03	.03
Handling tools and objects	.1	.1	.2	.2	.1	.2	.2	.1
Heat	....	....	(1)	.9	1.0	(1)	(1)	(1)
Unclassified	3.4	.6	3.8	3.2	2.6	1.3	1.4	1.6
Total	3.7	.8	5.2	4.7	4.8	2.0	2.4	1.9
Number of workers	*2,211*	*1,951*	*2,366*	*2,637*	*2,433*	*2,925*	*2,691*	*1,905*

[1] Less than 0.005.

Here is an important group of workers having somewhat definitely rising rates during a period of general accident reduction. How has this come about? It is probably a case, like many others, where the responsible persons were entirely ignorant of the facts and so took no active steps to prevent this rise in rates. Two things might contribute to this ignorance: 1. The rates in sheet mills are below those in other lines of manufacture and so a rise might not seem seriously significant; 2. The rates for hot-mill crews may never have been considered separately. They were very likely combined with those of other workers whose rate was declining sufficiently to pull down the rate for the combined group.

Another possible element in this somewhat increasing rate during this period must not be overlooked. In these mills there has been a very great increase in tonnage since 1909. Since accident rates, both frequency and severity, are rising equally with this growing tonnage, the conclusion is almost unavoidable that this increasing product has been secured at some cost of greater hazard. It has not been thought necessary to examine the cause rates in the five-year period 1915 to 1919 with the same detail which was applied to the period ending in 1914. The situation in this second five-year period has been considered sufficiently to determine that in the course of it this tendency to accident among the hot-mill men has been checked, if not reversed. Table 32 shows frequency rates by accident causes for the hot-mill crew and other occupations of the sheet mills.

TABLE 32.—ACCIDENT FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR SHEET MILLS, 1907 TO 1914, BY OCCUPATIONS AND ACCIDENT CAUSES.

Accident cause.	Hot-mill crews.	Other occupations.	Total.
Working machines	7.7	4.5	5.9
Hot substances	1.1	2.2	1.7
Handling tools and objects	13.0	9.4	10.9
Heat	1.1	.1	.5
Unclassified	12.4	20.2	17.0
Total	35.3	36.4	36.0
Number of workers	*5,200*	*7,391*	*12,591*

MECHANICAL, FABRICATING, AND YARD DEPARTMENTS.

MECHANICAL DEPARTMENT.

The accident rates for the mechanical department, by principal causes and by years, are as follows:

TABLE 33.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE MECHANICAL DEPARTMENT, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	14.8	13.6	14.7	10.0	10.3	8.5	3.4	4.4
Cranes and hoists	5.6	4.5	3.4	4.0	2.2	1.6	1.7	2.0
Hot substances	4.5	2.5	2.7	3.3	5.0	3.0	3.5	1.8
Unclassified	59.1	70.8	56.1	44.2	31.1	27.9	28.2	27.3
Total	84.0	91.4	76.9	61.5	48.6	41.0	36.8	35.5
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	0.3	0.4	0.3	0.2	0.2	0.3	0.1	0.3
Cranes and hoists	.1	1.6	.03	.1	.1	.1	.1	.4
Hot substances	.1	1.6	1.2	.03	.03	.03	1.0	.03
Unclassified	2.9	3.8	3.7	4.0	2.7	1.6	2.5	.6
Total	3.4	7.4	5.2	4.3	3.0	2.0	3.7	1.3
Number of workers	*2,542*	*1,619*	*1,977*	*2,223*	*2,144*	*2,362*	*2,569*	*1,632*

The working machine is particularly characteristic of the mechanical department, and it is therefore desirable to determine as carefully as possible what the relations of this group of causes may be to other groups. Inspection of the figures for the various years covered by the table indicates that both frequency and severity rates for working machines are much below the rates of the unclassified group of causes which the mechanical department has in common with other departments. The working machine, therefore, is not the most important hazard, even in the department where it is particularly characteristic. The first task of the safety movement was to safeguard machines. When it became evident that this was less important than had been supposed to be the case, it led to some general lessening of activity in the direction of mechanical improvement. The protection of the worker against working-machine dangers is on the whole a rather simple matter, but the application of engineering skill to the broader problems of accident prevention is now and will be for a long time of the highest importance.

The general tendency indicated by the table is one of quite marked decline. For example, from 14.8 cases per 1,000,000 hours' exposure in 1907 there is a drop to 3.4 cases in 1913 for working machines. In severity the change is from 0.3 day per 1,000 hours' exposure to 0.1 day. The total frequency rate changes from 84.0 cases in 1907 to 36.8 cases in 1913. Here again, however, we have an illustration of the fact that frequency may decline without a corresponding decline in severity. Severity rates for the two years are 3.4 days in 1907 and 3.7 days in 1913.

FABRICATING SHOPS.

Table 34 presents the principal accident cause groups in fabricating shops over the period 1907 to 1914.

TABLE 34.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE FABRICATING SHOPS, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Working machines	14.1	9.7	16.0	16.1	19.4	24.9	21.2	12.3
Cranes and hoists	12.0	10.0	16.6	13.2	9.8	12.4	14.5	9.7
Hot substances	1.9	1.1	.8	2.1	2.6	3.5	2.9	1.1
Unclassified	66.3	40.6	56.5	63.3	67.3	64.0	58.0	43.0
Total	94.3	61.4	89.9	94.7	99.1	104.8	96.6	66.1
	Accident severity rates (per 1,000 hours' exposure).							
Working machines	0.4	1.6	0.2	0.4	0.2	0.3	0.3	0.1
Cranes and hoists	3.8	2.1	4.4	3.9	1.6	3.0	.2	1.7
Hot substances						.1	.03	
Unclassified	5.6	1.1	3.3	3.1	.7	2.4	1.8	.8
Total	9.8	4.8	7.9	7.4	2.5	5.8	2.3	2.6
Number of workers	*2,081*	*1,758*	*1,770*	*2,074*	*2,203*	*2,074*	*2,045*	*1,759*

As in the mechanical department, the working machine in fabricating is a characteristic hazard but of slightly more importance, as a comparison of the severity rates with those of the mechanical department will show.

An inspection of the operations in the fabricating shop will indicate that the danger of the reamers, riveters, and punchers is greater than that of lathe hands and planers. Much more serious than these dangers are those arising in connection with the use of cranes in fabrication. So frequent is the use of the crane and so closely related to the processes of the shop that it might almost be regarded as one of the working machines.

No important decline is indicated in the rates for working machines but cranes and hoists and the unclassified group show a material reduction.

ACCIDENT REDUCTION METHODS IN MECHANICAL DEPARTMENT AND FABRICATING SHOPS.

Among working machines, as has already been noted, punchers, reamers, and riveters contribute a considerable portion of hazard.

Heretofore the reamer has usually been actuated by compressed air. Since the pressure within the machine and in the hose conveying the air to the machine tends not only to produce the desired rotation but also to throw the entire machine about, it is quite frequently found that in the records the cause of accident is reported as "lost control of the machine." In the case of a reamer actuated electrically there is no such tendency, and the operation of the machine is much steadier and better subject to control. Substitution of electrically actuated reamers has been a material factor in reducing accidents in connection with the operation of such machines.

Considerable ingenuity and effort have been expended in an effort to devise a drill chuck which will hold the drill firmly when pressed against the work and allow it to turn backward freely when not actually operating. Since accidents with drills are of considerable frequency, and with drills of any considerable size may be serious, the production of a chuck which will be safer in operation is much to be desired. Up to the present time none of those devised have proved entirely satisfactory. The avoidance of drill accidents, therefore, remains for the most part a matter of personal care. The lathes that are now being put out by machine tool builders have their moving parts so completely inclosed and the necessary changes of speed accomplished in such a way that they present few danger points except those which the care of the operator must avoid.

Great progress has recently been made in the safeguarding of grinding wheels. The manufacturers of grinding machines now furnish them with hoods completely inclosing the wheel except at the grinding point, and these effectually retain fragments in case the wheel bursts. Small flying particles from the wheel may be guarded against by means of eye protectors worn by the men or by plate glass screens fastened to the machines. This latter device has one point of objection which is not always seriously enough considered. In the operation of the wheel there is always some degree of vibration. The effort to see an object through a glass thus vibrating is apt to strain the eyes seriously.

The metal planer is the only working machine which has a record of any considerable number of fatal injuries. All of those recorded in connection with the cases investigated arose from failure to close the openings in the bed of the machine on which the working platform moves back and forth. An illustrative case will show the nature of the hazard. A workman used a space within the planer bed to store some of his tools. Reaching over to secure one of them he slipped and fell into the opening. He was caught and crushed by the moving platform. It is so simple a matter (see Plate 19, "A") to close these openings that the continued existence of this hazard should be regarded as criminal.

Pattern shops and carpenter shops associated with the mechanical or fabricating departments are apt to retain saws and wood planers not provided with the safeguards which the best modern practice requires.

The high rates in connection with cranes and hoists which are shown particularly in the fabricating shop indicate that some cranes of primitive pattern are still in use and that the use of chains of inadequate strength, or which have been overstrained, still continues.

YARD DEPARTMENT.

Table 35 contains the frequency and severity rates for the principal cause groups in the yard department.

TABLE 35.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE YARD DEPARTMENT, 1907 TO 1914, BY YEARS AND ACCIDENT CAUSES.

Accident cause.	1907	1908	1909	1910	1911	1912	1913	1914
	Accident frequency rates (per 1,000,000 hours' exposure).							
Cranes and hoists	6.5	6.6	5.8	2.3	1.8	4.0	2.2	1.7
Hot substances	2.8	4.8	4.1	1.9	1.7	1.4	1.1	.5
Falling objects	10.6	15.5	9.2	10.9	8.3	6.7	3.6	2.7
Power vehicles	13.8	5.2	7.8	12.3	7.9	11.2	6.7	7.4
Unclassified	33.1	31.8	35.3	20.9	16.6	17.2	10.4	11.8
Total	66.8	63.9	62.2	48.3	36.3	40.5	24.0	24.1
	Accident severity rates (per 1,000 hours' exposure).							
Cranes and hoists	0.4	0.1	1.4	0.1	0.1	1.4	0.03	0.2
Hot substances	.9	.2	.1	.1	.03	.03	(1)	(1)
Falling objects	1.0	1.7	.1	.1	.2	.3	.1	.1
Power vehicles	2.3	.4	6.4	2.6	2.7	1.1	.4	.3
Unclassified	2.2	.6	.5	.6	.4	.2	.2	1.9
Total	6.8	3.0	8.5	3.5	3.4	3.0	.7	2.5
Number of workers	*2,618*	*1,522*	*1,891*	*2,134*	*1,810*	*2,078*	*2,751*	*1,356*

[1] Less than 0.005.

None of the accident cause groups appear to be of sufficient importance to call for special comment except the "power vehicles" group. Comparing 1907 with 1913 the frequency rates for power vehicles declined 51 per cent (from 13.8 cases per 1,000,000 hours' exposure to 6.7 cases) and severity declined 83 per cent (from 2.3 days per 1,000 hours' exposure to 0.4 day). Probably a fairer comparison is that of two four-year periods, 1907 to 1910 and 1911 to 1914. This shows frequency declining 15 per cent and severity 61 per cent. This indication of improving condition is especially important in view of the fact that greater difficulties undoubtedly surround the control of hazard in connection with transportation than of dangers found in other departments. In the report published by the bureau in 1913 no appreciable improvement in the hazard of yard departments could be established.

The coupling and uncoupling of cars were during the period covered by the table the cause of the largest number of injuries. The fatalities in connection with yard operation were very largely due to being run over by moving cars and engines. In this particular group were five such cases and but one fatality in connection with coupling. Four of the five fatalities due to being run over occurred in the earlier of the two four-year periods. The smaller number in the second period unquestionably reflects a general improvement in yard conditions.

SAFETY METHODS IN YARDS.

In all transportation, whether industrial or public, the grade crossing presents the most serious problem. It is worthy of notice that the elimination of this hazard is almost entirely a matter of cost. There is no engineering reason why railway tracks in plant yards should not uniformly be elevated or depressed. The reason that

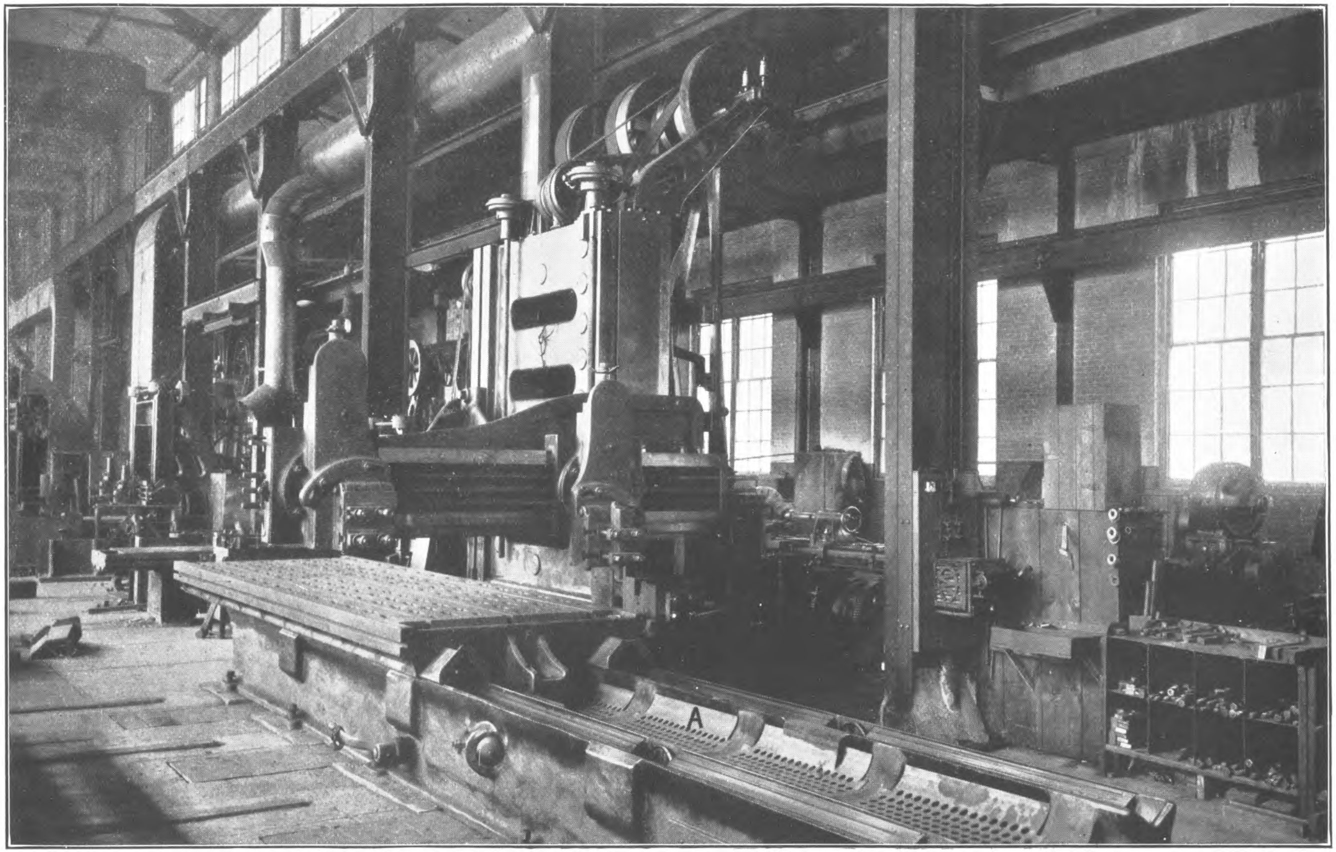


PLATE 19.—METAL PLANER, WITH SAFETY PLATES CLOSING OPENING IN BED.

PLATE 20.—YARD TRESTLE, WITH VARIOUS SAFETY DEVICES.

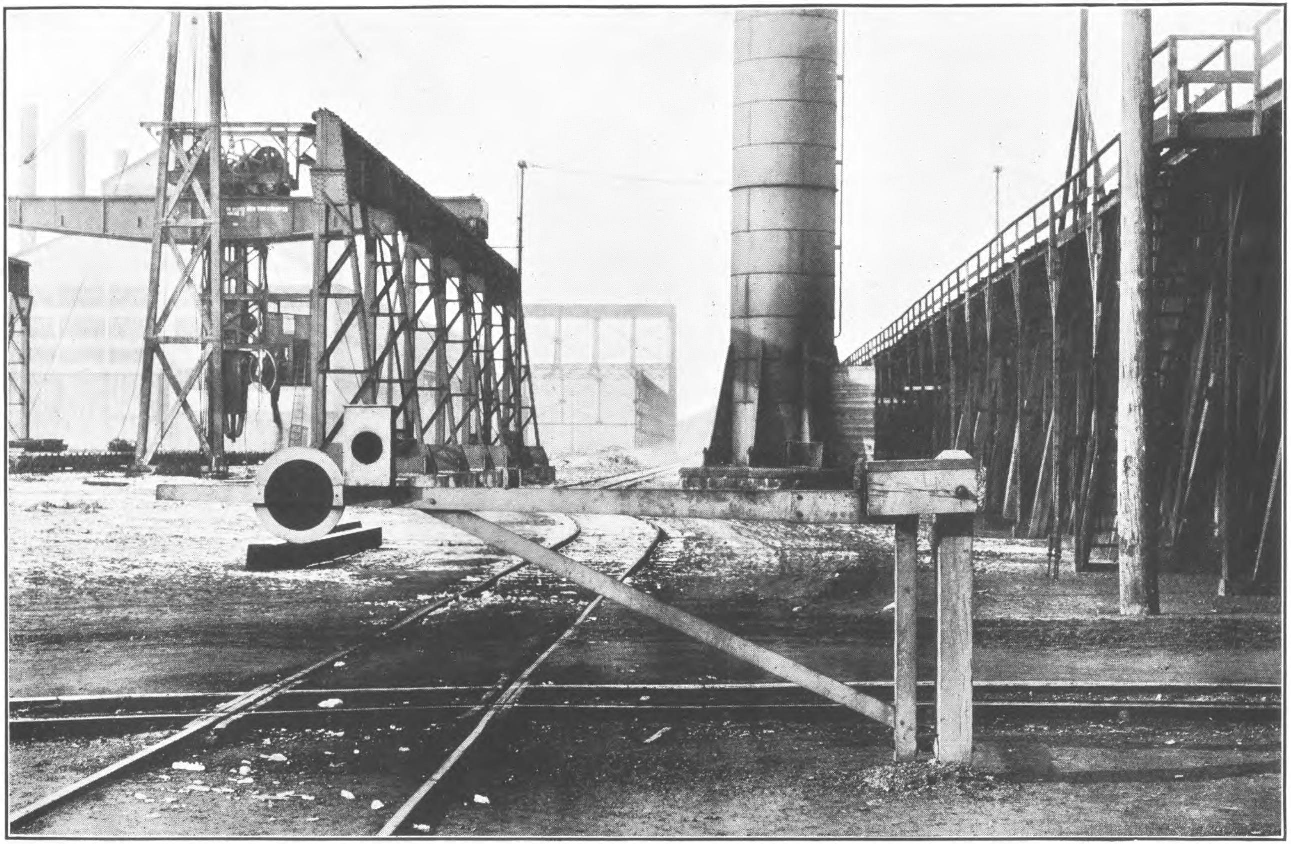


PLATE 21.—SAFETY GATE FOR CROSSING OF TRACKS.

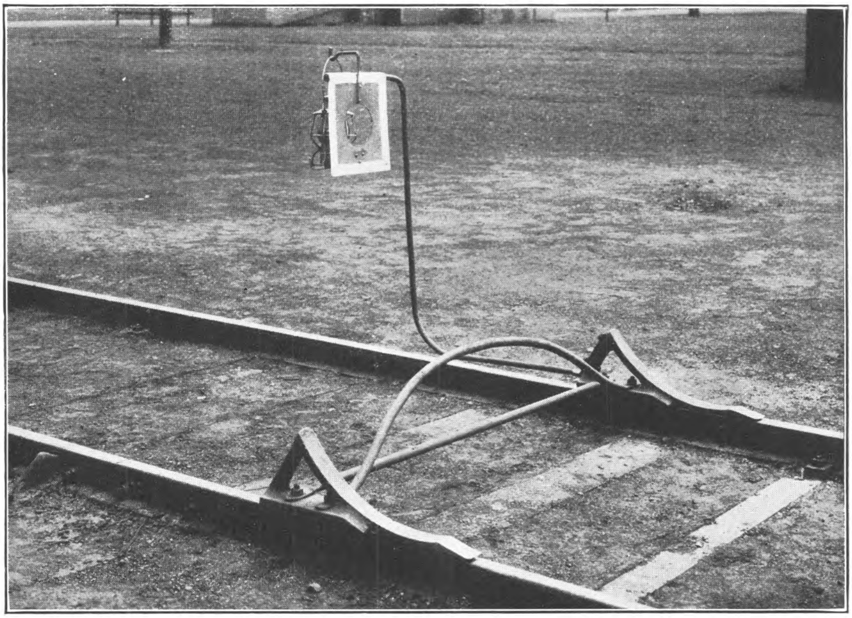


PLATE 22.—SKIDDER WITH TARGET ATTACHMENT.

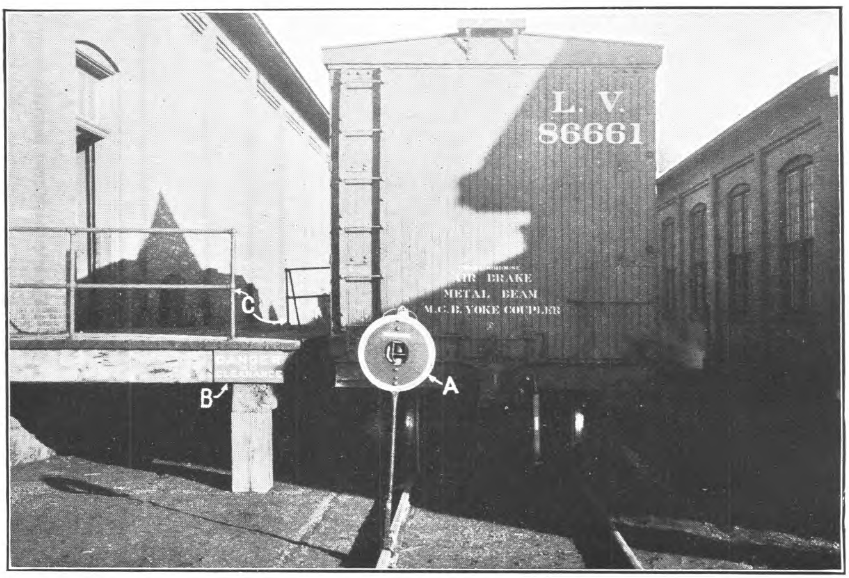


PLATE 23.—TARGET SIGNAL, USABLE DAY OR NIGHT.

this is not done is that to do so is a costly procedure. There ought to be a very great extension of arrangements which abolish the grade crossing in industrial plants (see Plate 20).

Wherever it is impossible to avoid relation between tracks on which vehicles move and crossings there should be a very careful installation of convenient and permanent signal apparatus. A permanently located signal which needs only to be adjusted is greatly preferable to one which must be sought out and put in place by the members of the train crew (see Plate 21). For signaling, which is necessarily temporary, some standard form should be adopted and arrangements made to fasten the signal in position so that it can not be displaced except by intention (see Plates 22 and 23).

A safety man who has succeeded in eliminating as completely as possible the grade crossings from his plant, has established proper clearances, and adopted some permanent signaling scheme is ready to turn his attention to automatic couplers and the proper equipment of gantry and locomotive cranes which are used in the yards.

The locomotive crane has received considerable attention from the safety men, and the makers now produce this apparatus with many safety ideas incorporated.

Since this machine travels under its own power, some of the dangers incident to ordinary engines are connected with it. For example, if it is not provided with an automatic coupler it may serve to increase the roll of accidents due to coupling and uncoupling. If it is not provided with appropriate grab irons the craneman may suffer a serious fall in attempting to get into his cab. It is chiefly, however, in connection with its use as a hoisting apparatus that danger arises. Probably more accidents have arisen in this connection from attempting to lift weights beyond the capacity of the machine, causing it to tip over, than from any other. At some point there should be an inscription stating the capacity of the crane. An indicator should be provided from which the craneman may determine safe loads in varying positions of the boom. In some plants a device has been applied which rings an alarm as soon as tipping begins. Safeguards equivalent to these are now embodied in the cranes produced by the best makers.

Among minor improvements in yard conditions is the replacing of a type of switch in which the lever operated at right angles to the track by one in which the lever moves parallel to the track. It will be seen that in the old type a man exerting himself in moving the lever might fall forward directly upon the track. Several fatalities from this cause are on record. Under the old conditions the V-shaped openings in the track frogs had no protection and the foot of the switchman could be so caught therein that he would be unable to get out of the way of an approaching train. These openings have now been very generally blocked up with metal or wooden guards.

It may be noted that in the interior transportation of a plant there is precisely the same hazard which arises on the public highway. Whenever the danger is related to a moving object, which may approach at varying degrees of speed, the danger becomes serious and can be met only as suggested above, by removing the path of the moving object from that of the moving man or by the utmost care and skill on the part of the operator and of the man endangered.

CHAPTER V.—PHYSICAL CAUSES OF ACCIDENT—RELATION OF CAUSES TO LOCATION, NATURE, AND RESULTS OF INJURY.

In the preceding chapters the effort has been to establish the relation of the causes to the departments and of the departments to each other, and to point out some of the possible methods of combating hazard in the departments.

Attention will now be directed to the worker himself and what effect the various causes may have upon him. There are three subjects which may be treated in this review of the man's relation to the causes, namely, the location of the injury, the nature of the injury, and the final results of the injury.

These subjects do not have as direct a bearing on accident prevention as do those already presented, but it is not possible to consider the relations of the causes from any viewpoint without at times getting very definite hints regarding preventive measures. For example, when in blast furnaces a high rate for injury to the skull appears as due to falling bodies the usefulness of the so-called "hard-boiled" caps is forcibly suggested.

CAUSES AND LOCATION OF INJURY.

Table 36 presents the facts regarding the severity of the injuries resulting from certain causes and affecting certain portions of the body.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY.

Location of injury.	Blast furnaces.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	(1)	(1)	0.96	0.34	(1)	0.73	1.19
Skull	3.42	3.41	1.14	2.64	3.42	1.14	1.14
Other parts of head	1.15	.04	1.16	1.17	1.18	.02	.03
Face and neck	1.14	.02	.23	.03	(1)	.05	.02
Trunk.							
Back	(1)	.01	.10	.03	.10	.09	(1)
Vertibræ	1.14						
Thorax	3.42	5.75	3.44	.07	(1)	.02	.01
Abdomen	.01	3.42	1.14	(1)	(1)	(1)	1.14
Groin	.02	.01		.01		.07	
Pelvis	.04	2.27					
Generative organs				.01		(1)	
Upper extremities.							
Clavicle				(1)	.02		
Shoulder	.01	.01	.02	.03	.02	(1)	
Upper arm		(1)		(1)		(1)	
Elbow		(1)	(1)	.02	(1)	.01	(1)
Ulna		.01		.01			
Radius				.01			
Ulna and radius				.01			.01
Forearm	.02	(1)	.05	.01	(1)	(1)	.02
Wrist	.01	.02	.02	.03	(1)	.01	(1)
Hand	.82	.04	.10	.03	.02	.69	.01
Both hands			.08		.01		
1 finger	.86	.05	.02	.01	.02	.47	.01
2 fingers	.07	.14	(1)	(1)	.14	.02	
3 fingers	(1)					.02	
4 fingers	.34						
Thumb	.27	.03	(1)	(1)	.01	.10	(1)
Thumb and 1 finger			.23				
Lower extremities.							
Hip	(1)			.02			(1)
Femur	.06	1.14		.07	.06	(1)	
Upper leg	.77	.87	.05	1.15	(1)	.03	.02
Knee	.78	.02	.01	.05	.01	.03	.01
Tibia		.01			.12		
Fibula				.01			
Tibia and fibula	.03	.03			.07		
Lower leg	.03	.02	.08	.02	.04	.02	(1)
Ankle	.04	.01	.11	.45	.03	.04	.06
Foot	.03	.48	.35	.03	.14	.21	.05
Both feet			.09		(1)		(1)
Great toe	.01	.02	.01	.01	.14	.22	(1)
Great toe and other toes	.06				(1)	(1)	(1)
Other toes					(1)	(1)	
Unclassified		1.14	9.13	1.14			10.28
Total	14.52	18.95	18.54	7.42	5.50	4.02	14.03

[1] Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Bessemer.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	(1)		0.09		0.01	0.08	1.29
Skull				0.03			
Other parts of head	.09	3.69	.01	(1)	.05	(1)	.02
Face and neck	.05		.21			.07	.01
Trunk.							
Back	.01		.22	.04		.05	.07
Thorax	11.04	3.69	7.63	.26	.09	.07	(1)
Abdomen	(1)		.22	(1)	3.67	.08	
Groin						.10	
Upper extremities.							
Clavicle							.04
Shoulder			.02	.11	.01	(1)	(1)
Upper arm			(1)				
Elbow		.01					(1)
Radius	.02						
Ulna and radius		.21		.03			
Forearm		(1)	.10			(1)	
Wrist	.02			.04	(1)	.06	
Hand	.03	.02	.08		(1)	.33	(1)
Both hands			.10				
1 finger	.66	.71		(1)	.03	.69	(1)
2 fingers	.02		.02		.03	.02	
3 fingers	.73						
Thumb		.76			.03	.06	(1)
Lower extremities.							
Hip		.04					
Femur	.12			.27			
Upper leg	.02	3.72	.03	.04		.03	.03
Knee	.07	.02		.20			.05
Tibia	3.74						
Fibula	.03			.02			
Tibia and fibula	.02	.04		.16			
Lower leg	.02	.25	.08	.02	.22	.12	.02
Ankle		.07	.12	.03	.02	(1)	.05
Foot	.01	.25	.43	.11	.20	.11	.08
Great toe	.02	.01			.53	.34	.05
Great toe and other toes		.01			.01	.02	
Other toes					.03	.01	
Unclassified			14.68		3.67		(1)
Total	16.74	13.51	24.03	1.36	8.61	2.26	1.74

1 Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE), FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Open hearths.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.20		0.45	0.01	0.15	0.20	0.71
Skull	3.93	0.02			2.92		(1)
Other parts of head	1.06	.02	.04	.05	.04	.03	.02
Face and neck	1.01	.99	.45	.04	(1)	.03	.01
Trunk.							
Back	.03	.02	.28	.02	.05	.10	(1)
Vertibræ		.97				(1)	
Thorax	4.97	4.91	2.09	.07	1.01	.04	.99
Abdomen	1.95	.01	(1)	.01	(1)	.98	(1)
Groin	(1)					.04	.03
Pelvis	1.06	(1)			.97	(1)	
Generative organs	.01		(1)			.01	(1)
Upper extremities.							
Clavicle	.01			.03	.01		.01
Shoulder	(1)	.01	.04	.03	.97	.01	(1)
Humerus	.01			.04	.03		
Upper arm		(1)	.01	(1)		.01	(1)
Elbow	(1)	.01	.01	.02	(1)	.01	(1)
Ulna		.01		.02			
Radius	.01	.01		.03		.01	.01
Forearm	(1)	.01	.07	.04	.01	.02	.01
Wrist	(1)	.01	.02	.05	.01	.03	.01
Hand	.31	.68	.14	.04	.04	.16	.03
Both hands			.37			(1)	
1 finger	.78	.57	.01	.01	.09	.86	.01
2 fingers	.09	.13	(1)	.01	(1)	.17	.01
3 fingers	.01	(1)			(1)	.01	
Thumb	.43	.21	.01	.01	.02	.29	.01
Thumb and 1 finger	(1)						
Thumb and 2 fingers	.24		(1)				
Lower extremities.							
Hip	.01	.01	(1)	.02	.01	(1)	(1)
Femur	.08	.01		.11	.97		
Upper leg	1.04	1.02	1.05	.02	.01	.02	(1)
Knee	.01	.02	.01	.05	.01	.02	.02
Tibia	.02			.02			
Fibula	(1)	.01		.02			
Tibia and fibula		.01		.04	.13		
Lower leg	1.03	.04	.15	.06	.05	.04	.04
Ankle	.10	.06	.14	.12	.05	.05	.11
Foot	.69	1.01	.39	.05	.21	.25	.06
Both feet		.98	.03			(1)	
Great toe	.06	.02	.01	(1)	.27	.21	.01
Great toe and other toes	.05				.01	.01	
Other toes	.05				.01	.01	
Unclassified			10.81	(1)			.02
Total	19.25	11.76	16.45	1.04	8.07	3.63	2.14

[1] Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Foundries.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.05		0.11			0.11	0.80
Skull	1.96	0.01				(1)	(1)
Other parts of head	.02	.01	1.98	0.01	0.04	.01	.01
Face and neck	.02		.09	1.96	(1)	.03	.01
Trunk.							
Back	.05	.01	.02	.01	.03	.11	(1)
Thorax	2.03	.01	2.06	.06	.02	.04	.01
Abdomen	.02		.01	.01	(1)	.01	(1)
Groin						.22	(1)
Pelvis	3.91						
Upper extremities.							
Scapula	(1)						
Shoulder	.02			(1)	(1)	(1)	(1)
Humerus	.01						
Upper arm	(1)		(1)		(1)	.01	(1)
Elbow	(1)		(1)	(1)	(1)	.01	.01
Radius				.01		.04	
Forearm	.03		.03	(1)	.01	.01	.03
Wrist	.06		.03	.02	(1)	.04	.06
Hand	1.85		.07	.01	.06	.18	.11
Both hands	(1)		.06			.01	
1 finger	1.06	.01	(1)	.05	.09	1.23	.16
2 fingers	.32	.02	(1)	(1)	(1)	.02	.01
3 fingers	.01		(1)				
Thumb	.78	.01		.20	.01	.33	(1)
Thumb and 2 fingers						(1)	
Lower extremities.							
Hip	.01			(1)		(1)	
Femur					.01		.02
Upper leg	.19	(1)	(1)	(1)	2.01	1.32	(1)
Knee	.01	(1)		.02	.06	.02	.01
Tibia	.05				.04		
Fibula	.03						
Tibia and fibula	.05				1.98		
Lower leg	.08	(1)	.01	.01	.39	.08	.08
Ankle	.09		.13	.05	.08	.03	.12
Foot	.17	.02	.38	.01	.45	.25	.10
Both feet			.07				
Great toe	.14	.02			.45	.22	.02
Great toe and other toes	.02		(1)		.04	.03	
Other toes							(1)
Unclassified			1.96				(1)
Total	13.04	.12	7.02	2.45	5.78	4.39	1.58

1 Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Heavy rolling mills.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.01	....	0.74	....	(1)	0.83	0.30
Skull	.76	1.47	....	0.03	0.01	(1)	.74
Other parts of head	.80	....	.01	.02	.02	.02	.07
Face and neck	.05	(1)	1.51	.03	(1)	.06	.01
Trunk.							
Back	.02	.01	.03	.03	(1)	.09	(1)
Thorax	.77	1.49	.07	.08	(1)	.02	.02
Abdomen	.01	1.47	.01	(1)	....	.03	.01
Groin	(1)	(1)	....	.01	....	.04	....
Pelvis	.01	(1)	....	.02	....	....	....
Generative organs	....	....	....	(1)	....	(1)	....
Upper extremities.							
Scapula	....	....	....	.01	.02	....	....
Clavicle	....	.01	....	.01	....	....	....
Shoulder	.01	.10	(1)	.01	(1)	.01	(1)
Humerus	....	....	....	.01	....	....	....
Upper arm	.49	....	(1)	(1)	(1)	(1)	....
Elbow	(1)	....	....	(1)	....	(1)	.02
Ulna	....	....	....	.01	....	.01	(1)
Radius	....	....	....	.01	....	.02	....
Ulna and radius	.02	.01	....	....	....	....	....
Forearm	(1)	(1)	.02	.01	(1)	.01	(1)
Wrist	.01	....	(1)	.03	(1)	.01	.01
Hand	1.16	.37	.05	.02	.01	.19	.02
Both hands	....	....	.07	(1)	....	....	....
1 finger	.72	.04	....	(1)	.06	.62	.01
2 fingers	.48	....	(1)	....	.01	.13	....
3 fingers	.36	.15	....	....	....	(1)	....
4 fingers	.01	....	....	....	....	....	....
Thumb	.25	.01	(1)	(1)	.16	.16	(1)
Thumb and 2 fingers	.18	....	....	....	....	....	....
Lower extremities.							
Hip	(1)	....	....	(1)	(1)	.03	.01
Femur	.54	....	....	.02	(1)	....	.74
Upper leg	1.57	.49	.01	(1)	.02	.01	.76
Knee	.03	.01	....	.03	.01	.01	.02
Tibia	....	....	....	....	.02	....	.01
Fibula	.03	....	....	.01	....	.02	.01
Tibia and fibula	.02	.01	....	.01	.34	.05	(1)
Lower leg	.83	.03	.01	.01	.04	.05	.02
Ankle	.06	(1)	.05	.06	.04	.03	.07
Foot	.43	.19	.12	.13	.53	.22	.08
Both feet	....	....	.02	....	....	(1)	....
Great toe	.24	.05	....	(1)	.23	.13	.01
Great toe and other toes	.07	....	....	....	.01	.01	(1)
Other toes	.02	....	....	....	.10	(1)	(1)
Unclassified	.74	....	2.95	(1)	(1)	....	.01
Total	10.72	5.92	5.71	.61	1.67	2.83	2.96

[1] Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Plate mills.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	(1)		0.05	(1)		0.01	0.11
Skull	4.08				(1)		.01
Other parts of head	.04	0.01	.01	0.01	0.02		.01
Face and neck	.05	.02	1.41	(1)	(1)	.06	.01
Trunk.							
Back	.04	(1)	.02	.03	(1)	.08	(1)
Vertebræ	1.36			.03			
Thorax	.03		.01	.06	.03	.04	(1)
Abdomen	1.38		1.36	(1)		.03	.03
Groin	(1)				(1)	.05	(1)
Pelvis	1.38						
Generative organs						.01	(1)
Upper extremities.							
Clavicle	.01			.02			
Shoulder	.03		.01	.01	(1)	.01	(1)
Humerus	(1)						
Upper arm	(1)	(1)		(1)			(1)
Elbow	.01			(1)	(1)	.01	.02
Ulna	.01			.02			
Radius						.01	
Ulna and radius					.04		
Forearm	.04	.01	.02	.07	.01	.03	.03
Wrist	.01		.01	.01	(1)	.06	.01
Hand	.26	(1)	.03	.03	.03	.27	(1)
Both hands			.01				
1 finger	.61	.01	.02	.01	.08	.66	.01
2 fingers	.09		.01		(1)	.04	(1)
3 fingers	.06			(1)		(1)	
4 fingers	.41						
Thumb	.46		(1)		.15	.49	.01
Lower extremities.							
Hip	.02					.01	(1)
Femur	.08				.06		
Upper leg	.19	(1)	.02	.03	.01	.05	.14
Knee	.03	(1)	(1)	.02	.01	.01	.02
Tibia							.02
Fibula	.03					.01	.02
Tibia and fibula	.05				.54		.04
Lower leg	.19	(1)	.01	(1)	.12	.03	.01
Ankle	.08		.04	.05	.03	.02	.06
Foot	1.22	.01	.07	.01	.32	.21	.08
Both feet			.02		.03	(1)	
Great toe	.20	(1)	.01		.34	.26	.03
Great toe and other toes	.20				(1)	.02	
Other toes	(1)				.01	.01	
Unclassified				(1)			2.73
Total	12.63	.07	3.14	.41	1.85	2.49	3.43

1 Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Tube mills.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.58		0.05			0.61	0.10
Skull	1.79					.02	
Other parts of head	3.58			(1)	(1)	.01	.01
Face and neck	.02		1.80	0.04	(1)	.02	(1)
Trunk.							
Back	.04	0.02	.01	1.79	(1)	.04	.05
Thorax	3.64	(1)		.02	(1)	.08	.01
Abdomen	.01					.06	1.78
Groin						.06	
Pelvis						(1)	
Generative organs	.03			(1)		.01	(1)
Upper extremities.							
Clavicle						(1)	
Shoulder				.03	(1)	.01	
Elbow	(1)			(1)	(1)	(1)	
Ulna						.03	
Radius		.05		.01		.02	
Forearm	.03	.01	.02	.02		.02	.04
Wrist	(1)		(1)	.02	(1)	.01	
Hand	.60		.07	(1)	0.01	1.87	.05
Both hands			.01				
1 finger	.89				.04	.45	.11
2 fingers	.31		(1)		(1)	.03	(1)
3 fingers						(1)	
Thumb	.24	.18		(1)		.38	.21
Thumb and 1 finger		.44					
Lower extremities.							
Hip	.01			(1)	.01	.02	
Femur	.09			.05			
Upper leg	.01		.02	(1)	.01	.01	.05
Knee				.08	.01	.01	.05
Tibia					.04		
Fibula				.02			
Tibia and fibula					.16		
Lower leg	.03		.17	.01	.01	.01	(1)
Ankle	.02			.01	.02	.02	.02
Foot	.23	.10	.03	.01	.16	.15	.04
Both feet			.01				
Great toe	.03				.04	.10	03
Great toe and other toes	.10						
Other toes					.23		
Unclassified	.01					(1)	1.78
Total	12.29	.80	2.18	2.13	.76	4.06	4.35

[1] Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Sheet rolling mills.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.03		0.01			1.03	0.06
Other parts of head	(1)			0.03	0.01		.01
Face and neck	.01		.03			.05	.04
Trunk.							
Back	(1)		.02	(1)		.07	
Thorax				.01		.08	
Groin						.16	
Upper extremities.							
Shoulder	(1)		.02			.02	
Upper arm				.01		.03	.01
Elbow				(1)		.06	
Forearm	.02		.08	.03	.02	.41	.06
Wrist	.01		(1)	.01		.21	.01
Hand	.11		.06	.02		.41	.08
Both hands			.01			.01	
1 finger	1.01				.17	1.32	.25
2 fingers	.93					.07	
3 fingers	.02					.01	
4 fingers	1.01						
Thumb	.02			.04	.01	.12	(1)
Lower extremities.							
Hip	(1)			.01			
Upper leg	.02		.03			.01	(1)
Knee	.01		(1)	.08		.18	.04
Tibia					.06		
Fibula				.02			.04
Tibia and fibula	.06				.30		
Lower leg	.06		(1)			.05	.16
Ankle	(1)			.13		.61	.24
Foot	.17	0.01	.02	(1)	.24	.48	.36
Both feet	.01						
Great toe	.02				.08	.09	(1)
Unclassified						(1)	
Total	3.54	.01	.28	.41	.89	5.49	1.37

1 Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Fabricating.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	1.13		0.03			0.22	0.28
Skull	3.61			1.80			
Other parts of head	.05			.02	0.02	.02	.01
Face and neck	.06	0.01	.04	.06	[1]	.06	.02
Trunk.							
Back	.05	[1]				.07	[1]
Thorax	3.66	[1]		.07	1.80	.04	[1]
Abdomen	.03						
Groin				.01		.04	
Upper extremities.							
Clavicle	.02	.02					
Shoulder	.01	.01		[1]	[1]	[1]	
Humerus	.08			.01	.01		
Upper arm	.03		[1]		.01	.01	
Elbow	.01			.02		.01	
Ulna	.02				.02		
Radius	.01			.01			
Ulna and radius	.04						
Forearm	.06		.01	[1]	.04	[1]	.01
Wrist	.03			.01		.02	
Hand	.12	[1]	.02	.02	.02	.08	.04
1 finger	3.22	.02	.01	.01	.24	.77	.22
2 fingers	.59				.02	.11	[1]
3 fingers	.37					[1]	
4 fingers	[1]						
Thumb	1.03		[1]	[1]	[1]	.10	.02
Lower extremities.							
Hip	[1]			.03	[1]	[1]	
Femur	.15			.07	.03		
Upper leg	.05		[1]	.02	.01	.01	[1]
Knee	.04	.03		.06	.01	.03	.07
Tibia	.03				.03		
Fibula	.17			.02			
Lower leg	1.36		.01	.02	.02	.08	.02
Ankle	.10			.03	.02	.01	.03
Foot	2.12	[1]	.03	.02	.28	.13	.05
Great toe	.28			[1]	.37	.18	.02
Great toe and other toes	.02				.11	.01	
Unclassified			1.80	[1]			1.80
Total	18.54	.10	1.95	2.30	3.10	2.00	2.59

[1] Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Electrical.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.09		0.04		(1)	0.07	0.07
Skull	9.62			4.81			
Other parts of head	.06		9.70	.06	0.01	.01	(1)
Face and neck	4.85	(1)	.17	4.84			(1)
Trunk.							
Back		0.02	.05	.16		.04	
Thorax	9.59		(1)	(1)		.01	(1)
Abdomen	.02			(1)		.01	
Groin				.05		.09	.02
Pelvis	.11			.07			
Upper extremities.							
Clavicle					.02		
Shoulder			.01	.06		(1)	
Upper arm	3.18						
Elbow	(1)		.01	.18	.01	(1)	(1)
Ulna				.05	.04		
Radius				.02	.03		
Forearm			.01	.01		.02	
Wrist	.06		.03	.16	.01	.01	(1)
Hand	1.72	.05	.30	.03	.02	.06	.01
Both hands			.06				(1)
1 finger	.33		.01		.01	.98	.04
2 fingers	1.19		(1)			.62	
3 fingers			.01				
Thumb	.03		(1)		.01	.07	
Thumb and 1 finger	.01						
Lower extremities.							
Hip	.02			.01			
Femur	.02						
Upper leg	(1)	.02	.05	.01		.01	(1)
Knee	.03			.04			.01
Fibula	.05						
Tibia and fibula				.35	.04		
Lower leg	(1)		.06	.02	.01	.03	.05
Ankle	.01	.04	.02	.21	.02	.01	.14
Foot	.33	.03	.14	.08	.27	.10	.06
Great toe					.03	.11	.03
Great toe and other toes	.03						
Unclassified			14.33				4.79
Total	31.39	.16	24.99	11.22	53	2.24	5.25

1 Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Mechanical.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.59	....	0.03	....	([1])	1.01	1.57
Skull	.82	0.81	....	3.24	0.01	.01	....
Other parts of head	.02	.01	.82	.02	.08	.01	.83
Face and neck	.04	....	.88	.02	([1])	.04	.01
Trunk.							
Back	.04	.01	([1])	.02	.03	.07	([1])
Thorax	4.06	.01	....	.05	.83	.01	.01
Abdomen	.01	.81	([1])	.01	([1])	.82	....
Groin	([1])	....	....	.01	([1])	.17	.01
Pelvis	.81	....	....	.03	....	.01	....
Generative organs	....	.01	([1])	([1])	....	([1])	....
Upper extremities.							
Scapula	([1])	....	....	....	....	([1])	....
Clavicle	.01	....	....	([1])	....	.01	....
Shoulder	.01	([1])	([1])	.05	.03	.02	.03
Humerus	.02	....	....	.02	....	....	....
Upper arm	.01	....	([1])	([1])	([1])	([1])	.01
Elbow	.01	([1])	....	.07	.01	.02	.01
Ulna	....	....	....	.01	....	.01	....
Radius	.01	([1])	....	.01	....	.01	....
Ulna and radius	([1])	....	....	.03	....	.01	....
Forearm	.05	....	.03	.01	.01	.02	.01
Wrist	.02	.01	.01	.09	.01	.02	.01
Hand	.32	([1])	.06	.02	.02	.63	.02
Both hands	([1])	....	.01	....	....	....	.01
1 finger	1.90	....	([1])	.01	.12	.85	.01
2 fingers	.38	([1])	([1])	....	.01	.11	([1])
3 fingers	.17	....	....	....	....	([1])	....
4 fingers	([1])	....	....	([1])	([1])	....	....
Thumb	.61	....	([1])	.01	.02	.75	.01
Thumb and 1 finger	.33	....	....	....	....	([1])	....
Thumb and 2 fingers	.20	....	....	([1])	....	....	....
Lower extremities.							
Hip	([1])	([1])	....	.03	([1])	([1])	([1])
Femur	.02	....	....	.04	....	....	([1])
Upper leg	.03	.61	.01	.05	.04	.04	.56
Knee	.01	.01	([1])	.05	.01	.04	.06
Tibia	.02	.03	....	.02	....	....	....
Fibula	.02	....	....	.04	([1])	.01	....
Tibia and fibula	.07	.37	....	.01	.03	....	.01
Lower leg	.05	.02	.03	.01	.04	.03	.02
Ankle	.06	.01	.04	.13	.02	.01	.07
Foot	.57	.02	.04	.01	1.08	.24	.03
Both feet	....	([1])	([1])	....	([1])	....	....
Great toe	.13	.01	([1])	....	.12	.25	.01
Great toe and other toes	.02	([1])	....	....	.01	.01	....
Other toes	.01	([1])	....	....	([1])	([1])	....
Unclassified	....	....	.81	.81	....	....	.82
Total	11.42	2.76	2.79	4.93	2.54	5.24	4.17

[1] Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

Location of injury.	Yards.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.62	0.01	0.04			1.28	1.99
Skull	2.04	4.08					2.04
Other parts of head	2.05	6.17	(1)	(1)	0.02	.01	.01
Face and neck	.01	.04	.05	0.02	(1)	.02	.05
Trunk.							
Back	.02	.13	.02	.03	.01	.10	
Thorax	4.17	16.51		.06	.01	.04	2.04
Abdomen		2.04			(1)	(1)	4.08
Groin		.02				.11	
Pelvis		2.08					
Generative organs		.01					(1)
Upper extremities.							
Clavicle				(1)		.03	
Shoulder	.01	.04	.01	.03	.05	(1)	.03
Humerus		.05				.05	
Upper arm		1.54			(1)		(1)
Elbow		.01			.03		(1)
Ulna	.01						.04
Radius		.04		.01			.01
Ulna and radius		.01				(1)	
Forearm	(1)	1.37	(1)		.01	.02	
Wrist	(1)	.01	(1)	.05	.02	.01	
Hand	(1)	.35	.02	.01	(1)	.09	.01
Both hands		(1)	.02				
1 finger	.60	1.36	.01	(1)	.02	.58	.01
2 fingers	.01	.37				.31	(1)
3 fingers		.01			.02		
Thumb	.25	.73		.01	(1)	.05	
Thumb and 1 finger		(1)					
Lower extremities.							
Hip	.01	.01			(1)		(1)
Femur	.06	.08					1.36
Upper leg	1.38	2.18	.01	.01	2.06	.03	.01
Knee	(1)	.07		.02	.01	.01	.08
Tibia		.06			.03		
Fibula				.04		.01	
Tibia and fibula	(1)	.18					.06
Lower leg	.04	2.38	.04	(1)	.02	.06	.01
Ankle	.07	.15		.05	.04	.03	.13
Foot	.07	7.73	.08	.03	.25	.29	.10
Both feet			(1)			(1)	(1)
Great toe	.01	.23	(1)	(1)	.23	.22	.01
Great toe and other toes	.10	.11			.09	(1)	
Other toes	.01	.10			.01	.01	
Unclassified	2.04	4.09	.02				.01
Total	13.57	54.35	.31	.38	2.94	3.36	12.09

1 Less than 0.005.

TABLE 36.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Concluded.

Location.	Unclassified.						
	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Head.							
Eye	0.25	(1)	0.15	(1)	(1)	0.59	1.01
Skull	1.10	0.36	....	1.81	0.38	(1)	.37
Other parts of head	.38	.03	.73	.38	.03	.03	.39
Face and neck	.04	(1)	.10	.02	(1)	.04	.01
Trunk.							
Back	.02	.01	.02	.40	.01	.11	.01
Vertebræ	....	....	....	(1)	....	....	....
Thorax	2.60	2.18	.40	.05	.73	.04	.73
Abdomen	1.46	.72	(1)	.01	.72	.02	.37
Groin	.01	....	(1)	(1)	(1)	.14	.01
Pelvis	.37	.36	....	(1)	....	(1)	....
Generative organs	(1)	....	....	(1)	(1)	(1)	(1)
Upper extremities.							
Scapula	....	....	....	....	(1)	(1)	(1)
Clavicle	(1)	(1)	....	....	(1)	(1)	(1)
Shoulder	.03	.01	(1)	.02	.01	.02	.01
Humerus	.01	.24	....	(1)	....	(1)	(1)
Upper arm	.52	....	(1)	(1)	(1)	(1)	(1)
Elbow	.03	(1)	(1)	.01	....	.01	.01
Ulna	.01	(1)	....	.01	....	(1)	....
Radius	(1)	.01	....	.02	....	(1)	(1)
Ulna and radius	.01	....	....	.01	....	....	(1)
Forearm	.04	(1)	.06	.02	.01	.04	.02
Wrist	.04	.01	.01	.03	(1)	.06	.02
Hand	.71	.01	.04	.02	.04	.22	.04
Both hands	....	....	.02	(1)	(1)	(1)	....
1 finger	.72	.03	.01	.03	.07	.92	.04
2 fingers	.22	.05	.01	....	.01	.11	(1)
3 fingers	.11	....	....	....	(1)	.01	.07
4 fingers	.22	....	....	....	....	.09	....
Thumb	.59	(1)	(1)	.04	.04	.30	.01
Thumb and 1 finger	(1)	....	(1)	....	....	....	....
Thumb and 2 fingers	(1)	....	(1)	....	....	(1)	....
Thumb and 3 fingers	....	....	(1)	....	....	....	....
Lower extremities.							
Hip	.01	(1)	(1)	.01	(1)	.01	(1)
Femur	.04	.25	....	.04	.25	(1)	.02
Upper leg	.63	.37	.02	.02	....	.02	.02
Knee	.01	.01	.01	.04	.37	.03	.03
Tibia	(1)	.01	....	.02	.02	.01	.01
Fibula	(1)	....	....	....	.01	.01	(1)
Tibia and fibula	.08	(1)	....	.02	.28	.08	.03
Lower leg	.69	.97	.06	.03	.09	.05	.03
Ankle	.03	.01	.02	.07	.03	.03	.08
Foot	.50	.42	.29	.04	.67	.39	.09
Both feet	(1)	(1)	.01	(1)	(1)	(1)	(1)
Great toe	.07	.01	.15	(1)	.26	.23	.01
Great toe and other toes	.01	....	(1)	....	(1)	.01	(1)
Other toes	.01	....	....	....	.03	.01	.02
Unclassified	.02	.36	1.82	(1)	....	....	1.85
Total	11.59	6.44	3.95	3.17	4.08	3.63	5.31

1 Less than 0.005.

Blast furnaces.—In blast furnaces the highest severity rate (10.28 days per 10,000 hours' exposure) is found in the group unclassified both as to cause and locality. It will appear later that this rate is due to asphyxiating gas, which is still among the most serious menaces of the blast furnace. Injuries to the thorax and the abdomen caused by power vehicles have each a high rate and taken together contribute nearly half the loss due to that cause (9.17 out of 18.95 days). Injuries to the skull have a high rate in all cause groups, but particularly machinery (3.42 days), falling objects (3.42 days), power vehicles (3.41 days), and falls of worker (2.64 days).

Hot substances have their most serious effect on the thorax (3.44 days), abdomen (1.14 days), and in general burns not confined to a specific locality (9.13 days).

Bessemer department.—In this department the highest severity rate (14.68 days per 10,000 hours' exposure) arises from hot substances not classified in regard to location. Among these would be included, of course, such extensive burns as happen from time to time in the departments handling molten metal. Next in severity (11.04 days) are injuries to the thorax arising from the operation of machinery. It should be noted that the machinery cause group includes cranes and hoists as well as working machinery. Power vehicles give rise to serious injuries in a number of cases; for example, to the head (3.69 days), to the thorax (3.69 days), and to the leg (3.72 days).

Open hearths.—In this department as in the preceding, hot substances causing general injuries have the highest severity rate (10.81 days). Injuries to the thorax caused by machinery have a rate of 4.97 days; those caused by vehicles, 4.91 days; and those caused by hot substances, 2.09 days.

Foundries.—In the foundries, machinery is the cause of greatest severity of accident (13.04 days). The location of the most severe of these injuries is in the pelvis (3.91 days) and the thorax (2.03 days). Falling objects are in this department a source of considerable severe injury; as, for example, 2.01 days for injuries to the leg.

Heavy rolling mills.—Machinery is in this department the cause of greatest severity (10.72 days). There is no particular location which stands out above the others in its contribution to this severity rate. Other cause groups similarly present a fairly uniform distribution of severity among the different locations.

Plate mills.—Machinery and hot substances (12.68 and 3.14 days) are distinctly the largest contributors to severity in this department. Among machinery injuries those to the skull are markedly more serious (4.08 days) than those of any other location.

Tube mills.—Machinery (12.29 days) makes the largest contribution to severity, injuries to miscellaneous parts of the head (3.58 days) and to the thorax (3.64 days) being in the lead. Handling objects and tools is not usually a large contributor to severity, but in this department injuries to the hands and fingers constitute an important element. This seems to arise very largely in the handling of pipe in the process of threading and in moving it from place to place.

Sheet rolling mills.—This department is particularly conspicuous for the severity of the injuries occurring in connection with handling objects and tools, being in that respect much more so than the tube mills just mentioned. This high degree of severity is largely related to the process of opening the packs of sheets. Injuries to the eye, in connection with handling, are also rather serious (1.03 days).

Fabricating.—Machinery is the most important cause of severity in this department. Injuries to the thorax (3.66 days) are the most important. A rather notable feature of these machinery accidents is the severity of those which involve one finger (3.22 days), which undoubtedly arise from the necessity of moving rather clumsy and unmanageable objects with the crane. In guiding and adjusting these objects the workers rather frequently get a finger caught. It is also noticeable that injuries to the foot have a conspicuous severity rate (2.12 days.) The heavy girders and other fabricated parts from time to time tip over and in doing so are apt to catch the worker. This is reflected in the rate of 1.80 days for injuries to the thorax caused by falling objects.

Electrical.—It is somewhat surprising, as has already been noted, that machinery causes the larger number of severe injuries in this department (31.39 days). This is, of course, connected with the work which the men have to do in repairing and adjusting electrical machines of various sorts. Most serious of these injuries are those of the skull (9.62 days). Hot substances, which include electricity, are next in order of severity (24.99 days), general injuries which can not be definitely located being the most serious (14.33 days). Following these are injuries to parts of the head (9.70 days). The effect of electrical shock, not accompanied by burns, is shown in the rate of 4.79 days for unclassified causes producing injuries not classified by locality.

Mechanical.—The mechanics suffer most severely from machinery, injuries to the thorax standing at the head of the list (4.06 days). They also suffer noticeable severity from injuries involving the hands, those to one finger showing a rate of 1.90 days. These mechanics include those who are obliged to work on elevations, such as riggers, and who are thus more or less exposed to the danger of falling. This is reflected in injuries to the skull, due to falls of the worker (3.24 days). As might be expected the mechanics show a rather high rate (5.24 days) in the handling of objects and tools. The location of the most serious injuries is the eye, with a rate of 1.01 days. All the departments show considerable severity from these eye injuries, and since they are injuries which are almost completely preventable by the provision of proper eye protectors and the securing of the cooperation of the men in using them, they deserve very serious attention.

Yards.—No cause of injury in any department shows as high a severity rate as power vehicles in the yard department (54.35 days). Injuries to the thorax (16.51 days) are the most serious. But throughout the list of locations high rates are found; such as, for example, foot, 7.73 days, parts of head, 6.17 days, and skull, 4.08 days. These injuries are, of course, almost entirely due to the movements of cars through the yards and buildings. The fact that similar high rates prevail in connection with the operation of railways suggests that there is still room for careful study with a view to the further reduction of the accident hazard in these occupations. Along with the erection of structural steel transportation remains a department which, while affected by the safety movement, has been less modified than could be desired.

Unclassified.—The only comment that it is desired to make on this department is to call attention to the fact that it also emphasizes the importance of machinery as a cause of severe injury.

CAUSES AND NATURE OF INJURY.

In the preceding section the various cause groups have been related to the part of the body which sustained injury. It is now proposed to consider the nature of those injuries and the cause groups by which they were produced. Table 37 contains the severity rates, classified by cause groups and by the nature of injury.

TABLE 37.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY.

BLAST FURNACES.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	[1]	[1]		0.02	[1]	0.03	0.48
Bruise	0.85	0.15	[1]	.17	0.27	.38	1.19
Cut							[1]
Laceration	1.45	.10	[1]	.44	.07	.66	.41
Puncture	.06	[1]	[1]	.02	.01	.41	.02
Burn or scald	.02		16.01	1.14		.01	.35
Concussion				1.14			[1]
Dislocation	.01			.02	.01	.01	
Fracture	7.26	7.85	1.14	3.27	2.71	1.44	1.19
Sprain or strain (not hernia)	.01	.03		.06	[1]	.12	.07
Accidental dismemberment	1.20	.14	.23		1.14	.11	
Nervous shock							[1]
Abrasion with infection	.01	[1]	[1]	[1]	[1]	.01	.02
Cut with infection						.57	
Laceration with infection					.02	.04	
Puncture with infection						.03	
Burn or scald with infection			.01				
Fracture with infection						.01	[1]
Hernia	.02			.01		.05	
Asphyxia				[2]1.14		.01	9.14
Electric flash	.06	[1]	.01				
Crushing injury	3.57	10.67			1.28	.12	
Electric shock			1.14				
Loss of teeth						.01	
Unclassified	[1]					[1]	1.14
Total	14.52	18.95	18.54	7.42	5.50	4.02	14.03

BESSEMER.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	[1]	0.04	[1]	0.01		0.01	0.12
Bruise	0.21	.18		.32	0.24	.35	.16
Laceration	.13	.15		.02	.27	.28	.18
Puncture	[1]					.11	1.10
Burn or scald			23.99		.09	.03	.01
Dislocation				.03			[1]
Fracture	4.28	.40	.03	.74	.25	.54	.06
Sprain or strain (not hernia)		.01		.25	[1]	.19	.05
Accidental dismemberment	.73	.37			.01	.37	
Abrasion with infection					.01	.03	.01
Laceration with infection						.10	[1]
Burn or scald with infection			[1]				
Hernia						.08	
Crushing injury	11.38	12.36			4.07	.18	.03
Heat exhaustion							[1]
Unclassified					3.67		
Total	16.74	13.51	24.03	1.36	8.61	2.26	1.74

FOUNDRIES.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	0.07	[1]	[1]	0.01	0.04	0.08	0.78
Bruise	.62	0.04		.10	.74	.68	.13
Laceration	1.59	.01		.05	.28	1.05	.12
Puncture	.01			[1]		.05	.15
Burn or scald	.01		7.00				[1]
Dislocation	[1]					[1]	
Fracture	3.83	.06		2.22	2.69	1.65	.16
Sprain or strain (not hernia)	.01	.01		.07	.01	.22	.10
Accidental dismemberment	.30						
Abrasion with infection					.01	.21	.11
Laceration with infection						.01	.01
Puncture with infection						.01	
Burn or scald with infection			[1]		[1]		
Hernia						.22	[1]
Asphyxia							[1]
Electric flash			.01				
Crushing injury	6.59				2.00	.21	
Heat exhaustion							[1]
Total	13.04	.12	7.02	2.45	5.78	4.39	1.58

[1] Less than 0.005.

[2] This worker was gassed and fell from an elevation.

TABLE 37.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Continued.

OPEN HEARTHS.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	0.02	(1)	(1)	0.02	0.01	0.03	0.08
Bruise	.58	0.27	....	.18	.34	1.42	.09
Cut	(1)	....	....	....	....	(1)	....
Laceration	.42	.17	(1)	.16	.39	.57	.39
Puncture	(1)	.01	....	(1)	.01	.18	.04
Burn or scald	(1)	....	16.61	.02	....	.02	.32
Concussion	.01	(1)	....	....	....	....	(1)
Dislocation	(1)	.01	....	.01	....	(1)	....
Fracture	8.16	2.67	(1)	.52	4.27	.61	.02
Sprain or strain (not hernia)	.01	.02	....	.13	.01	.16	.12
Accidental dismemberment	.68	.41	....	....	.05	.24	....
Nervous shock	....	....	(1)	(1)	....	....	(1)
Abrasion with infection	(1)	....	(1)	(1)	.97	.09	.03
Laceration with infection	.01	....	(1)	....	....	.03	.01
Puncture with infection	....	....	....	....	....	.01	....
Burn or scald with infection	....	....	.01	....	....	....	....
Hernia	....	....	....	....	....	.05	.03
Asphyxia	....	....	....	....	....	....	.01
Electric flash	....	....	.01	....	(1)	....	....
Crushing injury	9.37	8.21	....	....	2.01	.21	.97
Heat exhaustion	....	....	....	....	....	....	.01
Electric shock	....	....	(1)	....	....	....	....
Unclassified	....	....	(1)	....	....	....	....
Total	19.25	11.76	16.65	1.04	8.07	3.63	2.14

HEAVY ROLLING MILLS.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	0.02	....	0.01	(1)	0.01	0.02	0.05
Bruise	.27	0.03	....	0.15	.19	.32	.12
Laceration	.48	.03	....	.06	.13	.76	.16
Puncture	.01	....	.23	....	....	.35	.01
Burn or scald	.01	....	5.45	.02	....	.01	.01
Concussion	.74	....	....	....	(1)	.01	....
Dislocation	.03	....	....	(1)	....	(1)	....
Fracture	2.41	1.41	....	.32	.76	.53	1.56
Sprain or strain (not hernia)	.51	.01	....	.05	.02	.18	.07
Accidental dismemberment	.70	....	....	....	.11	.15	....
Nervous shock	.04	....	....	(1)	....	....	....
Abrasion with infection	....	....	....	....	(1)	.02	.02
Laceration with infection	.74	....	....	....	....	(1)	.22
Puncture with infection	....	....	....	....	....	(1)	(1)
Burn or scald with infection	....	....	.01	....	....	....	....
Fracture with infection	....	....	....	.01	....	.04	....
Hernia	....	(1)	....	(1)	....	.03	....
Asphyxia	....	....	....	....	....	....	(1)
Electric flash	....	....	.01	....	....	....	....
Crushing injury	4.77	4.44	....	....	.45	.41	.74
Heat exhaustion	....	....	....	....	....	....	(1)
Loss of teeth	(1)	....	....	....	....	....	....
Unclassified	.01	....	....	....	....	(1)	(1)
Total	10.72	5.92	5.71	.61	1.67	2.83	2.96

[1] Less than 0.005.

71087°—22——8

TABLE 37.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Continued.

PLATE MILLS.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	0.01			(1)	0.01	0.02	0.11
Bruise	1.84	0.06		0.10	.33	.33	.14
Cut						(1)	(1)
Laceration	1.04	.01		.12	.28	.68	.20
Puncture	(1)				.02	.08	.06
Burn or scald	.08		3.13	.01	(1)	.01	
Concussion				(1)	(1)		
Dislocation	(1)			.01		.02	
Fracture	7.52	(1)		.10	.96	.40	.12
Sprain or strain (not hernia)	.01			.07	(1)	.14	.06
Accidental dismemberment	.75				.20	.42	
Nervous shock	.07						
Abrasion with infection	(1)					.01	(1)
Cut with infection	(1)						
Laceration with infection						(1)	(1)
Puncture with infection						.03	
Burn or scald with infection			(1)				
Hernia						.06	(1)
Asphyxia			(1)				
Electric flash			.01				
Crushing injury	1.34				.04	.30	
Heat exhaustion							2.73
Loss of teeth	.01					(1)	
Total	12.68	.07	3.14	.41	1.85	2.49	3.43

TUBE MILLS.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	0.01			(1)	(1)	0.03	0.12
Bruise	.13	0.01		1.85	0.09	.26	1.89
Cut						.02	
Laceration	2.22	.11		.04	.07	.80	.15
Puncture	.05					.06	.03
Burn or scald	.01		2.17				
Concussion	1.78						
Dislocation					.01	(1)	
Fracture	.58	.05		.20	.34	.52	.05
Sprain or strain (not hernia)	.03			.03	.01	.08	.01
Accidental dismemberment	.98					.27	
Abrasion with infection		.01				1.78	.01
Laceration with infection						(1)	.04
Puncture with infection						(1)	
Burn or scald with infection			(1)				
Hernia						.05	
Electric flash			(1)				
Crushing injury	6.50	.62			.24	.19	.27
Heat exhaustion							1.78
Unclassified							.01
Total	12.29	.80	2.18	2.13	.76	4.06	4.35

SHEET ROLLING MILLS.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Abrasion	(1)						0.06
Bruise	0.24			0.10	0.17	0.56	.04
Laceration	.28	0.01		.05	.10	1.81	.84
Puncture						.04	.02
Burn or scald			0.28	.01		(1)	
Concussion				.02			
Dislocation				.04			
Fracture	.28			.02	.45	.31	.12
Sprain or strain (not hernia)	.01			.15		.56	.12
Accidental dismemberment	2.70				.17	1.37	.17
Abrasion with infection						.09	
Laceration with infection						.24	
Hernia						.14	
Crushing injury	.01					.38	
Total	3.54	.01	.28	.41	.89	5.49	1.37

[1] Less than 0.005.

TABLE 37.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Continued.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
FABRICATING.							
Abrasion	0.02			[1]		0.03	0.26
Bruise	1.71	0.04		0.10	0.30	.26	.05
Cut						[1]	
Laceration	1.69	.03		.11	.19	.54	.09
Puncture	.57				[1]	.07	.08
Burn or scald	.01		1.94			[1]	.01
Dislocation	.10			.01		[1]	.01
Fracture	5.43	.02		1.98	.44	.62	.13
Sprain or strain (not hernia)	.05	.01		.08		.09	.06
Accidental dismemberment	.95					.09	
Abrasion with infection	[1]		.01		[1]	.02	[1]
Cut with infection						[1]	
Laceration with infection	.10					.01	.01
Burn or scald with infection			.01				
Hernia				.01		.04	
Asphyxia							[1]
Electric flash			[1]				
Crushing injury	7.93				2.19	.22	.09
Loss of teeth						[1]	
Unclassified							1.81
Total	18.54	.10	1.95	2.30	3.10	2.00	2.59
ELECTRICAL.							
Abrasion	0.04			0.01		0.02	0.08
Bruise	.16	0.12		.28	0.10	.11	.04
Laceration	.98	[1]		.11	.12	.28	.06
Puncture				.01		.01	.05
Burn or scald	.01		10.53				
Dislocation	[1]				.02		
Fracture	14.76	.05		10.44	.28	.16	.04
Sprain or strain (not hernia)		[1]		.26	[1]	.09	.15
Accidental dismemberment						1.07	
Abrasion with infection	[1]					.03	.05
Laceration with infection				[1]		.05	
Puncture with infection						.26	
Hernia				.04		.06	
Asphyxia							4.77
Electric flash			.14				
Crushing injury	15.43					.09	
Heat exhaustion							.02
Electric shock			14.32				
Loss of teeth				.05			
Total	31.39	.16	24.99	11.22	.53	2.24	5.25
MECHANICAL.							
Abrasion	0.06			[1]	0.01	0.11	0.12
Bruise	.31	0.06		0.17	.35	.47	.37
Cut						[1]	
Laceration	.51	.02		.08	.16	.53	.99
Puncture	.49				[1]	1.62	.06
Burn or scald	.03		1.16			[1]	.01
Concussion					.01		
Dislocation	.01			.07		[1]	.01
Fracture	2.43	1.27		3.64	1.08	1.15	.06
Sprain or strain (not hernia)	.04	.01		.11	.01	.12	.07
Accidental dismemberment	1.62				.04	.49	
Nervous shock				.81		[1]	[1]
Abrasion with infection	.01			.04	[1]	.16	.29
Laceration with infection	.81					.02	.81
Puncture with infection						.01	
Burn or scald with infection			[1]				
Hernia				.01		.16	.01
Asphyxia							.82
Electric flash			.01				
Crushing injury	5.10	1.40			.88	.38	.54
Heat exhaustion							[1]
Electric shock			.81				
Loss of teeth	[1]						
Frosted							.01
Unclassified			.81	[1]	[1]		
Total	11.42	2.76	2.79	4.93	2.54	5.24	4.17

[1] Less than 0.005.

TABLE 37.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Concluded.

Nature of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
YARDS.							
Abrasion	0.01	0.05		(1)	(1)	0.03	2.12
Bruise	.18	.94		0.12	0.21	.38	.12
Laceration	.17	.73		.04	.15	1.48	1.96
Puncture		(1)			.01	.05	4.13
Burn or scald	2.08	.02	0.28				
Dislocation		.05		.01	.04		
Fracture	2.40	9.41		.14	.39	.51	3.54
Sprain or strain (not hernia)	(1)	.17		.07		.16	.15
Accidental dismemberment	.41	5.21				.36	
Nervous shock		(1)		(1)			
Abrasion with infection	.61					.03	.03
Laceration with infection						(1)	.02
Puncture with infection						.02	
Fracture with infection		2.04					
Hernia		.02				.12	
Asphyxia							(1)
Electric flash			(1)				
Crushing injury	7.70	35.71			2.14	.22	
Heat exhaustion							(1)
Electric shock			.02				
Unclassified							(1)
Total	13.57	54.35	.31	.38	2.94	3.36	12.09
UNCLASSIFIED.							
Abrasion	0.02	(1)		0.01	(1)	0.03	0.31
Bruise	.36	0.08		.15	0.74	.64	.14
Cut						(1)	(1)
Laceration	.53	.41		.09	.18	.78	.37
Puncture	.12	(1)		(1)	.01	.48	1.13
Burn or scald	.39		3.14	.01	(1)	(1)	.01
Concussion	(1)			.36	(1)		
Dislocation	.03	.01		.01		.01	(1)
Fracture	3.39	.91		2.41	1.29	.55	.48
Sprain or strain (not hernia)	.03	.01		.07	.01	.20	.08
Accidental dismemberment	2.50	.16		.02	.07	.39	
Nervous shock			(1)		.01		
Abrasion with infection	(1)			(1)	(1)	.04	.12
Cut with infection						(1)	
Laceration with infection	(1)	(1)				.02	.37
Puncture with infection				(1)		.01	(1)
Burn or scald with infection	(1)		.07			(1)	(1)
Hernia	(1)			(1)	(1)	.12	(1)
Asphyxia							1.81
Electric flash			.01				(1)
Crushing injury	4.22	4.50		.04	1.75	.36	.45
Heat exhaustion							.01
Frosted							(1)
Unclassified	(1)	.36	.72			(1)	.03
Total	11.59	6.44	3.95	3.17	4.08	3.63	5.31

1 Less than 0.005.

Blast furnaces.—The notable points under machinery are fracture (7.26 days per 10,000 hours' exposure) and crushing injury (3.57 days). The group of fractures, of course, includes those of the skull, which, since they often result in death, contribute largely to the severity rate for fractures. Power vehicles also give rise to severe fractures (7.85 days) and to crushing injuries (10.67 days). The most serious single cause is hot substances, giving rise to burns and scalds (16.01 days). These include those burns which rise from electric current. Under the head of electrical shock (1.14 days) is a case of death in which the electric current did not produce burns. In the blast furnace there is a considerable amount of work done at elevations from which there is a chance that the worker may fall. This possibility is illustrated by the rate (3.27 days) for falls of worker resulting in fracture. The fact that asphyxiating gas is a serious menace to the workers about the blast furnace appears in various ways at different points in the consideration of the department. In this table it is emphasized by the rate (9.14 days) under unclassified causes giving rise to asphyxia. In fact, of the unclassified causes this produces about two-thirds of the severity rate.

Bessemer.—In this department hot substances producing burns have the high severity rate (23.99 days). Next to this are power vehicles producing crushing injury (12.36 days), and next machinery producing crushing injury (11.38 days). In the Bessemer department a part of the process involves the throwing of heavy masses of scrap into the converters. In the best plants this is carried on in such a way that there is little danger of the material falling outside the converting vessel. In the older plants, however, it happens more or less frequently that these heavy masses fall to the floor below and inflict serious injury. This contributes materially to the rate of 4.07 days due to falling objects which produce crushing injury.

Open hearths.—In this department hot substances producing burns have a higher rate (16.61 days) than any other single cause. Following it are machinery causing crushing injury (9.37 days) and machinery causing fracture (8.16 days). The rate for falling objects producing fracture (4.27 days) is high enough to be noticeable.

Foundries.—Hot substances producing burns (7.00 days) leads in this department. Next to it comes machinery producing crushing injury (6.59 days) and machinery producing fracture (3.83 days). A considerable amount of severity is due to falling objects; for example, those producing fracture (2.69 days), and those producing crushing injuries (2.00 days).

Heavy rolling mills.—The highest rate in this department is for hot substances producing burns (5.45 days). Under machinery the rates for fracture (2.41 days) and for crushing injury (4.77 days) are noteworthy.

Plate mills.—The highest rate (7.52 days) is found under machinery producing fracture. Next to it comes hot substances producing burns (3.13 days). A hazard of considerable seriousness is present in the plate mills on account of the broad expanse of heated metal from which radiation may take place very rapidly. The result of this is shown in the severity rate (2.73 days) for unclassified causes producing heat exhaustion. Whenever workers are exposed to conditions such as this they are liable to heat cramps and other results of exposure to high temperature. Two methods of relief are available: (1) Streams of air so directed as to carry the heat away from the positions which the men occupy; and (2) an ample supply of good drinking water at the right temperature. If the water is too cold the men are apt to mistake the effect of the cold for the taking of a sufficient amount and an insufficient quantity is apt to be taken if the water has an unpleasant odor. The failure to supply the blood with sufficient liquid to replace that drawn off by profuse perspiration may have serious results. Some mills have found that the provision of an adequate and satisfactory supply of water has reduced the cases of heat exhaustion very materially.

Tube mills.—Machinery producing crushing injury (6.50 days) stands at the head of the list. There is a notable amount of laceration (2.22 days) connected with the operation of machinery in this department. This is related to facts already noted in considering location of injury. In the operation of threading pipes roughnesses are produced which cause more or less severe laceration of the hands. From the rate (1.78 days) for handling objects or tools giving rise to abrasion with infection it might be supposed that these mills gave inadequate attention to the minor injuries in connection with which infection is liable to occur. In all probability, however, this rate represents a comparatively few cases in which infection may have resulted in death. It does serve, however, to suggest forcibly the extreme precautions which it is desirable to take in order to avoid infection.

Sheet rolling mills.—The rates in this department are all of them rather low except for the handling of objects and tools. It has already been indicated that much of this injury is connected with the opening of the packs of sheets. To this may be attributed a large part of the rate (1.81 days) for handling giving rise to laceration. This is one of the departments in which the cause group "handling objects and tools" gives a higher severity than machinery. In the case of the latter, machinery producing accidental dismemberment shows the highest rate (2.70 days).

Fabricating.—Two items for this department are conspicuously more prominent than any of the others, namely, machinery causing crushing injury, with a rate of 7.93 days, and machinery causing fracture, with a rate of 5.43 days. Falling objects causing crushing injury have a rate of 2.19 days. As has already been suggested this is largely due to the falling over, from time to time, of the heavy girders and other structural forms which are produced in these shops.

Electrical.—The conspicuous rates in this department are found in machinery causing crushing injury (15.43 days), machinery causing fracture (14.76 days), and electricity giving rise to electric shock (14.32 days). It is very likely that falls of worker producing fracture (10.44 days) may be, in part, a result of the effect of the electrical current. These falls occur, for the most part, in the case of men employed as linemen. Table 12, page 386, shows that the injuries to linemen have a very high average severity. It is easy to infer that a considerable part of these disastrous falls are due to the receiving of an electric shock not in itself sufficient to do serious damage, but sufficient to cause the worker to loose his hold and fall from the elevation where he is working. A good deal of progress has recently been made in devising improved forms of protection for these men, and this high severity rate strongly emphasizes the need for utilizing all these protective devices. Under unclassified causes a rate of 4.77 days for those giving rise to asphyxia shows that in the course of the necessary electrical work about blast furnaces and some other departments of the iron and steel industry, the electrical worker is exposed to a considerable danger from asphyxiating gas. The development of test apparatus to show the presence of carbon monoxide and the development of gas masks and oxygen breathing apparatus ought to cut down this rate.

Mechanical.—Machinery causing crushing injury (5.10 days) shows the highest rate in this department. Falls of worker resulting in fracture stand next in order (3.64 days).

Yards.—As already noted under location of injury, power vehicles are the prime source of severe injury to yard employees. Crushing injury (35.71 days) is much the most serious. This, of course, is readily understood, since the duties of many of the employees require that they go between the cars, and it is evident that they are often caught and crushed. This group also includes those crushing injuries which occur in coupling and uncoupling. Another indication of the seriousness of injuries to the hand and fingers by being caught between the cars is the rate for accidental dismemberment (5.21 days). Fractures (9.41 days) includes, of course, fractures of the skull, which are of serious importance. Yard employees also suffer to a marked degree from crushing injuries due to machinery. A large part of these doubtless arise in connection with the operation of outdoor cranes. Under unclassified causes puncture wounds show a high rate (4.13 days). This rate reflects a considerable number of losses of the eye due to punctures and also somewhat frequent cases of injury due to sharp objects lying on the ground. It suggests, therefore, further attention to proper eye protection and also the need for strict requirements with regard to keeping the yards cleaned up.

Unclassified.—The highest rate (4.50 days) in this group is for power vehicles causing crushing injury. It is rather closely followed by crushing injury due to machinery (4.22 days). This miscellaneous group of workers does not present any other point of particular interest.

CAUSES AND RESULT OF INJURY.

It is usual to present the results of injury under three headings—death, permanent disability, and temporary disability. The last two are subdivided into a number of groups. In the ordinary presentation of accident rates on a frequency basis the rate for death is comparatively small, that for permanent disability usually somewhat higher, and that for temporary disability much the largest of the three. This arrangement of rates inevitably gives an appearance of relative unimportance to the death rate. Death is known to be the most serious form of industrial casualty. In spite of this fact, when it is represented by a small figure such as 0.8 case per 1,000,000 hours' exposure, while temporary disability is represented by 35.00 cases per 1,000,000 hours' exposure, the resulting impression is likely to be that temporary disability has an importance somewhat in proportion to the size of the figure which represents it. A great advantage of severity rates is that they throw these elements into more nearly their proper relation to each other; for example, in blast furnaces the rate for fatalities from machinery is 10.22 days per 10,000 hours' exposure; the rate for permanent disability is 3.72 days; and the rate for temporary disability is 0.58 day. It will be observed that this is to all appearances exactly opposite to the relation which would be shown by the frequency rate, and there can be no doubt that these severity rates more correctly represent the relative importance of the items than the frequency rates can possibly do. Because of this relationship it has been thought worth while to show in considerable detail, in this and other places, tables of severity rates classified in accordance with the results of the injury.

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY.

BLAST FURNACES.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	10.22	17.03	14.76	4.54	4.54	1.14	12.49
Permanent disability: Loss of—							
Both eyes			1.14				
1 hand	.57					.57	
1 leg	1.51	.85					
1 foot		.45					
1 eye			.85	.68		.68	1.02
1 thumb	.23						
1 finger	.45					.15	
2 fingers	.14	.12			.12		
3 fingers	.37						
4 fingers	.34						
Thumb and finger			.23				
Thumb and 3 fingers				.38			
Great toe	.06					.06	
Any 2 toes	.06						
Total	3.72	1.45	2.21	2.19	.12	1.48	1.02
Temporary disability, terminating in—							
1st week	.03	.04	.09	.06	.05	.21	.17
2d week	.04	.05	.19	.07	.09	.23	.11
3d week	.06	.02	.23	.06	.07	.25	.06
4th week	.03	.06	.16	.07	.05	.14	.05
5th week	.05	.03	.20	.08	.08	.12	.05
6th-13th week	.12	.18	.34	.25	.15	.25	.07
14th week and later	.24	.10	.36	.09	.33	.20	.02
Total	.58	.48	1.57	.68	.82	1.41	.52
Grand total	14.52	18.95	18.54	7.42	5.50	4.02	14.03

BESSEMER.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	14.68	11.00	22.02		7.34		
Permanent disability: Loss of—							
1 eye							1.10
1 thumb		.73					
1 finger	.55	.55				0.37	
3 fingers	.73						
Great toe					.37	.18	
All other						.18	
Total	1.28	1.28			.37	.73	1.10
Temporary disability, terminating in—							
1st week	.03	.03	.08	0.03	.07	.11	.11
2d week	.05	.04	.09	.03	.05	.16	.07
3d week	.02	.06	.15	.04	.12	.18	.07
4th week	.10		.20	.08	.11	.20	.01
5th week	.06	.06	.12	.08	.08	.10	.06
6th-13th week	.25	.31	.79	.39	.12	.40	.19
14th week and later	.26	.73	.58	.72	.36	.36	.13
Total	.78	1.22	2.01	1.36	.90	1.52	.64
Grand total	16.74	13.51	24.03	1.36	8.61	2.26	1.74

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY—Continued.

OPEN HEARTHS.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	15.59	7.80	13.64	....	6.82	0.97	0.97
Permanent dibility: Loss of—							
Both legs	....	.97	....	....	....	....	....
1 arm	....	.65	....	....	....	....	....
1 hand	....	....	.24	....	....	....	....
1 foot	.47	.78	....	....	....	....	....
1 eye	.19	....	.29	....	.15	.15	.58
1 thumb	.39	.19	....	....	....	.24	....
1 finger	.49	.44	....	....	....	.39	....
2 fingers	....	.12	.11	....	....	.11	....
3 fingers	.19	....	....	....	....	....	....
4 fingers	.05	....	....	....	....	....	....
Thumb and 2 fingers	.24	....	....	....	....	....	....
Thumb and 4 fingers	....	.05	....	....	....	....	....
Great toe	....	....	....	....	.10	....	....
Any 2 toes	.10	....	....	....	....	....	....
Total	2.12	3.21	.66	....	.24	.90	.58
Temporary disability, terminating in—							
1st week	.09	.04	.19	0.08	.10	.28	.18
2d week	.12	.05	.23	.09	.12	.26	.11
3d week	.13	.05	.38	.09	.11	.28	.07
4th week	.10	.09	.21	.07	.13	.21	.04
5th week	.13	.11	.24	.06	.12	.19	.04
6th-13th week	.41	.23	.64	.34	.24	.53	.07
14th week and later	.56	.21	.46	.33	.18	....	.07
Total	1.54	.76	2.35	1.04	1.00	1.76	.58
Grand total	19.25	11.76	16.65	1.04	8.07	3.63	2.14

FOUNDRIES.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	7.83	....	5.87	1.96	3.92	....	....
Permanent disability: Loss of—							
1 hand	.98	....	....	....	....	....	....
1 leg	....	....	....	....	....	1.30	....
1 eye	....	....	....	....	....	....	0.59
1 thumb	.59	....	....	.20	....	.20	....
1 finger	.59	....	....	....	....	.29	.20
2 fingers	.24	....	....	....	....	....	....
3 fingers	....	....	....	....	....	.39	....
Thumb and 4 fingers	.78	....	....	....	....	....	....
Great toe	....	....	....	....	.10	....	....
Any 2 toes	....	....	....	....	.10	....	....
Total	3.18	....	....	.20	.20	2.18	.78
Temporary disability, terminating in—							
1st week	.16	0.01	.07	.04	.10	.37	.21
2d week	.20	.01	.12	.05	.18	.47	.18
3d week	.20	.02	.11	.04	.17	.30	.05
4th week	.31	.01	.12	.03	.17	.21	.03
5th week	.21	.02	.10	.02	.11	.18	.04
6th-13th week	.68	.04	.43	.11	.52	.49	.17
14th week and later	.26	....	.20	....	.42	.18	.11
Total	2.04	.12	1.15	.30	1.68	2.21	.79
Grand total	13.04	.12	7.02	2.45	5.78	4.39	1.58

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY—Continued.

HEAVY ROLLING MILLS.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	5.16	4.42	4.42	....	....	....	2.21
Permanent disability: Loss of—							
1 arm	.49	.10	....	....	....	....	....
1 hand	1.01	.37	....	....	....	....	....
1 leg	.54	.49	....	....	....	....	....
1 foot	.29	....	....	0.09	0.59	....	....
1 eye	....	....	.66	....	....	0.77	.22
1 thumb	.18	....	....	....	.15	.07	....
1 finger	.59	.04	....	....	.04	.42	....
2 fingers	.47	....	....	....	....	.16	....
3 fingers	.29	.15	....	....	....	....	....
Thumb and 2 fingers	.18	....	....	....	....	....	....
Great toe	.25	.04	....	....	.07	.04	....
Any 2 toes	....	.04	....	....	.07	....	....
Total	4.32	1.22	.66	.09	.92	1.47	.22
Temporary disability, terminating in—							
1st week	.07	.01	.04	.05	.07	.18	.08
2d week	.09	.01	.06	.04	.07	.18	.05
3d week	.11	.01	.05	.04	.06	.15	.04
4th week	.11	.02	.05	.02	.07	.12	.04
5th week	.16	.02	.04	.01	.08	.12	.03
6th–13th week	.41	.06	.12	.23	.21	.35	.17
14th week and later	.29	.16	.25	.13	.19	.26	.12
Total	1.23	.28	.62	.53	.75	1.36	.53
Grand total	10.72	5.92	5.71	.61	1.67	2.83	2.96

PLATE MILLS.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	8.16	....	2.72	....	....	....	2.72
Permanent disability: Loss of—							
1 foot	.95	....	....	....	0.54	....	....
1 thumb	.41	....	....	....	.14	0.41	....
1 finger	.61	....	....	....	....	.27	....
Thumb and 3 fingers	.41	....	....	....	....	....	....
Great toe	.14	....	....	....	....	.07	....
Any 2 toes	.14	....	....	....	.07	....	....
Total	2.65	....	....	....	.75	.75	....
Temporary disability, terminating in—							
1st week	.10	0.01	.06	0.05	.12	.29	.14
2d week	.16	[1]	.08	.05	.14	.27	.10
3d week	.17	.02	.05	.03	.13	.18	.10
4th week	.20	....	.05	.06	.09	.14	.05
5th week	.14	.01	.05	.04	.09	.14	.07
6th–13th week	.64	.01	.09	.13	.26	.53	.11
14th week and later	.45	.02	.04	.07	.27	.19	.16
Total	1.87	.07	.42	.41	1.11	1.74	.71
Grand total	12.68	.07	3.14	.41	1.85	2.49	3.43

[1] Less than 0.005.

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY—Continued.

TUBE MILLS.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	7.10		1.78	1.78		1.78	3.55
Permanent disability: Loss of—							
Both eyes	1.78						
1 eye	.53					.53	
1 thumb	.18	0.18				.36	.18
1 finger	.89					.27	.09
2 fingers	.67				0.22		
Thumb and 2 fingers		.44					
Any 2 toes	.18						
Total	4.22	.62			.22	1.15	.27
Temporary disability, terminating in—							
1st week	.03		.02	.01	.02	.09	.06
2d week	.06	.01	.04	.04	.06	.17	.08
3d week	.05		.04	.03	.06	.14	.05
4th week	.08	.02	.02	.01	.04	.17	.05
5th week	.07	.01	.02	.03	.05	.09	.03
6th-13th week	.27		.07	.08	.07	.38	.09
14th week and later	.42	.15	.20	.16	.25	.08	.17
Total	.97	.18	.41	.35	.54	1.13	.53
Grand total	12.29	.80	2.18	2.13	.76	4.06	4.35

SHEET ROLLING MILLS.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death							
Permanent disability: Loss of—							
1 eye						1.01	
1 thumb						.17	
1 finger	0.84				0.17	.68	0.17
2 fingers	.84						
4 fingers	1.01						
Total	2.70				.17	1.86	.17
Temporary disability, terminating in—							
1st week	.05		0.04	0.04	.02	.37	.16
2d week	.10		.07	.07	.07	.72	.17
3d week	.05	0.01	.09	.03	.08	.56	.18
4th week	.06		.04	.07	.04	.44	.11
5th week	.09		.04		.02	.37	.07
6th-13th week	.27			.20	.09	.93	.51
14th week and later	.22				.41	.24	
Total	.83	.01	.28	.41	.72	3.63	1.20
Grand total	3.54	.01	.28	.41	.89	5.49	1.37

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY—Continued.

FABRICATING.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	9.00	...	1.80	1.80	1.80	...	1.80
Permanent disability: Loss of—							
1 leg	1.20	...	...	...	...	...	...
1 eye	1.08	...	...	...	...	...	...
1 thumb	.90	...	...	...	...	...	...
1 finger	2.34	...	...	...	.18	0.36	.18
2 fingers	.68	...	...	...	...	...	...
3 fingers	.36	...	...	...	...	...	...
Great toe	.18	...	...	...	...	...	...
Any 2 toes	...	...	...	...	.18	...	...
Total	6.74	...	...	...	.36	.36	.18
Temporary disability, terminating in—							
1st week	.22	0.01	.03	.06	.12	.25	.30
2d week	.47	.01	.04	.06	.19	.35	.17
3d week	.45	[1]	.04	.03	.15	.26	.05
4th week	.19	...	.02	.05	.09	.23	.04
5th week	.22	...	.02	.04	.06	.20	.04
6th-13th week	.67	.05	.01	.14	.22	.29	.01
14th week and later	.58	.03	...	.11	.10	.06	...
All other	...	...	...	[1]	...	...	...
Total	2.81	.10	.15	.50	.94	1.64	.61
Grand total	18.54	.10	1.95	2.30	3.10	2.00	2.59

ELECTRICAL.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	23.86	...	19.09	9.54	...	...	4.77
Permanent disability: Loss of—							
Both eyes	...	...	4.77	...	...	...	...
1 arm	3.18	...	...	...	...	...	...
1 finger	.24	...	...	...	...	0.72	...
2 fingers	1.19	...	...	...	...	.60	...
Thumb and 3 fingers	1.60	...	...	...	...	...	...
Great toe	.24	...	...	...	...	...	...
Total	6.44	...	4.77	...	...	1.31	...
Temporary disability, terminating—							
1st week	.08	0.01	.17	.09	0.03	.11	.17
2d week	.08	...	.16	.10	.06	.17	.07
3d week	.06	.02	.26	.04	.06	.15	.06
4th week	.18	.02	.14	.02	.02	.04	.02
5th week	.12	.02	.08	.12	.07	.10	...
6th-13th week	.36	.09	.24	.74	.28	.29	.16
14th week and later	.19	...	.07	.56	...	.07	...
Total	1.08	.16	1.12	1.67	.53	.93	.48
Grand total	31.39	.16	24.99	11.22	.53	2.24	5.25

[1] Less than 0.005.

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY—Continued.

MECHANICAL.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	6.46	1.62	2.42	4.04	1.62	0.81	1.62
Permanent disability: Loss of—							
1 hand	.40					.40	
1 leg		.54					.54
1 foot		.32				.32	
1 eye	.48					.91	1.40
1 thumb	.48					.32	
1 finger	.89				.08	.53	
2 fingers	.40						
3 fingers	.16						
Thumb and 1 finger	.32						
Thumb and 2 fingers	.20						
Great toe	.08					.04	
Total	3.43	.86			.08	2.53	1.94
Temporary disability, terminating in—							
1st week	.14	.01	.04	.07	.10	.26	.17
2d week	.14	.01	.06	.07	.09	.31	.10
3d week	.14	.01	.06	.06	.10	.26	.08
4th week	.16	.01	.04	.05	.13	.24	.04
5th week	.18		.05	.03	.07	.19	.03
6th-13th week	.42	.07	.09	.29	.25	.58	.12
14th week and later	.36	.17	.03	.30	.11	.07	.06
Total	1.53	.28	.37	.89	.84	1.91	.61
Grand total	11.42	2.76	2.79	4.93	2.54	5.24	4.17

YARDS.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	10.18	40.74			2.04		8.15
Permanent disability: Loss of—							
1 arm		2.89					
1 leg	1.36						1.36
1 foot		4.89					
1 eye	.61					1.22	1.83
1 thumb	.20	.61					
1 finger	.51	1.12				.31	
2 fingers		.25				.25	
Great toe					.10		
Any 2 toes	.10	.10					
Total	2.78	9.86			.10	1.78	3.19
Temporary disability, terminating in—							
1st week	.05	.23	0.04	0.05	.06	.18	.12
2d week	.06	.27	.02	.04	.05	.18	.09
3d week	.08	.27	.03	.07	.03	.18	.05
4th week	.05	.26	.04	.05	.06	.16	.05
5th week	.06	.24	.03	.03	.11	.18	.04
6th-13th week	.13	1.29	.15	.11	.29	.53	.21
14th week and later	.17	1.19		.03	.19	.17	.18
Total	.60	3.75	.31	.38	.80	1.58	.75
Grand total	13.57	54.35	.31	.38	2.94	3.36	12.09

TABLE 38.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSES AND RESULT OF INJURY—Concluded.

UNCLASSIFIED.

Result of injury.	Machinery.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.
Death	6.48	5.04	2.88	2.52	2.52	....	3.60
Permanent disability: Loss of—							
1 arm	.75	.24	....	....	....	....	....
1 hand	.36	....	....	....	....	0.09	....
1 leg	.24	.72	....	....	.48	.06	....
1 foot	.29	.14	.29	....	....	....	....
1 eye	.22	....	.11	....	....	.54	.88
1 thumb	.54	....	....	.04	.04	.16	....
1 finger	.54	.02	....	.02	.02	.46	.02
2 fingers	.27	.05	....	....	....	.05	....
3 fingers	.07	....	....	....	....	....	.07
4 fingers	.32	....	....	....	....	....	....
Great toe	....	....	....	....	.02	.02	....
Any 2 toes	.04	....	....	....	.05	.02	....
Other	....	....	....	.02	....	....	....
Total	3.64	1.17	.40	.07	.61	1.39	.97
Temporary disability, terminating in—							
1st week	.10	.02	.06	.05	.09	.34	.13
2d week	.15	.03	.09	.07	.10	.34	.11
3d week	.14	.04	.12	.06	.13	.33	.09
4th week	.13	.03	.06	.06	.10	.21	.07
5th week	.15	.02	.04	.05	.09	.27	.05
6th-13th week	.45	.06	.15	.16	.31	.57	.14
14th week and later	.36	.04	.15	.11	.13	.18	.15
Total	1.47	.23	.66	.58	.45	2.24	.74
Grand total	11.59	6.44	3.95	3.17	4.08	3.63	5.31

Blast furnaces.—It happens that in this particular group of blast furnaces death is most frequently caused by power vehicles (17.03 days per 10,000 hours' exposure). In other compilations hot materials stand at the head, while here they are in second place (14.76 days). Among the permanent disabilities those due to machinery, causing loss of the leg, have the highest severity (1.51 days). In this department, and practically all others, it is the rule that the severity rates increase as far as cases terminating in the third week and then begin to decline. That is, the large number of cases which terminate in the first week is not sufficient to offset the longer disability of the smaller number of cases running into the second and third weeks. If the frequency rates be consulted it would appear as though the disabilities of one week and under were the more important. The consideration of them from the standpoint of severity corrects that erroneous impression.

Bessemer.—Death due to hot materials is the most serious matter in this department (22.02 days). The time losses for temporary disabilities caused by hot substances are rather notable, the rate being 2.01 days.

Open hearths.—Death due to machinery (15.59 days) is a most important matter in this department, hot substances (13.64 days) and power vehicles (7.80 days) coming next.

Foundries.—Considerable disability, both of a permanent and temporary character, due to handling objects and tools is the striking feature in this department. The rate for permanent disability is 2.18 days and for temporary disability 2.21 days. The highest rate is that for death caused by machinery (7.83 days).

Heavy rolling mills.—Machinery causing death has a rate of 5.16 days, causing permanent disability 4.32 days, and causing temporary disability 1.23 days. Each of these rates is rather markedly in excess of those arising from other causes. Among the permanent disabilities those from machinery causing loss of hand are rather conspicuous (1.01 days).

Plate mills.—Machinery is even a more conspicuous factor in the seriousness of accidents of this department than in heavy rolling mills. The highest rate is found under machinery causing death (8.16 days).

Tube mills.—These mills also show high rates for machinery causing death (7.10 days) and permanent disability (4.22 days). Deaths due to unclassified causes show a rate of 3.55 days.

Sheet rolling mills.—This department is distinctive in that in the mills covered by this study there were no deaths in the 5-year period. It can hardly be supposed that in as large a group as that here covered this was accidental. In fact a knowledge of the operation of the department suggests that accidents causing death ought to be rather infrequent and perhaps ought, if the mills are properly managed, to be entirely absent, as they were in this case. Handling of tools and objects causing loss of the eye shows a high rate (1.01 days). A more extended use of eye protection in these mills would seem to be indicated. Temporary disability due to handling objects or tools is of considerable importance (3.63 days). As above noted, this is unquestionably due to the operation of opening the packs of sheets. Whether it is possible to devise some better protection for the hands of these workers is a question worth considering.

Fabrication.—Machinery is the great cause of serious injury in this department. Deaths due to machinery have a rate of 9.00 days; permanent disabilities, 6.74 days; and temporary disabilities, 2.81 days. It has elsewhere been shown that a considerable part of these severity rates are attributable to crane and hoisting apparatus; but the punches, reamers, and riveters are also a source of considerable severe injury.

Electrical.—Deaths due to machinery head the list in this department (23.86 days). Deaths due to electricity, either burns or electric shock (19.09 days), come next. The hazards of linemen are again emphasized by the deaths due to falls of worker (9.54 days).

Mechanical.—Most important among the mechanical workers are deaths due to machinery (6.46 days). Their permanent injuries due to machinery (3.43 days) and those due to handling objects or tools (2.53 days) are noticeable. Loss of eye and loss of hand or fingers due to machinery have a considerable degree of severity. In temporary disabilities the highest rate (1.91 days) is due to handling objects or tools.

Yards.—In this department additional evidence appears as to the importance of power vehicles as a cause of injury to the yard employees. Of the rate of 54.35 days for power vehicles, 40.74 days are attributable to death, 9.86 days to permanent disability, and 3.75 days to temporary disability. In connection with this high rate, which is not found elsewhere for a single cause group, with the possible exception of the erectors of structural steel, it is worth while again to call attention to the relation which the severity rate brings out between death, permanent disability, and temporary disability. In real importance these three results of injury stand in the order shown, whereas the frequency rates necessarily present them in the reverse order.

Unclassified.—There are no points in this group to which special attention need be directed.

CHAPTER VI.—VARIOUS RELATIONS OF LOCATION, NATURE, AND RESULT OF INJURY.

In the three preceding chapters the relation of the various accident causes to the departments, location, nature and results of the injury have been considered. There are various interrelations of these items which shed more or less light upon the accident problem. It is proposed in the present chapter to give consideration to these various relations.

DEPARTMENTS AND LOCATION OF INJURY.

Table 39 embodies the results of considering the departments as units and classifying the injuries occurring in them according to the part of the body injured.

TABLE 39.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION OF INJURY.

Location of injury.	Blast furnaces.	Bessemer.	Open hearth.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Head.													
Eye	3.23	1.49	1.70	1.07	1.88	0.17	1.33	1.14	1.66	0.28	3.19	3.93	2.01
Skull	17.43	.03	6.88	1.97	3.02	4.09	1.81	......	5.41	14.44	4.88	8.15	4.37
Other parts	4.75	3.86	1.25	2.08	.95	.11	3.61	.06	.12	9.82	1.78	8.26	1.97
Face and neck	1.49	.34	2.53	2.11	1.67	1.54	1.88	.13	.25	9.87	.99	.19	.22
Total	26.90	5.72	12.36	7.23	7.52	5.91	8.63	1.33	7.44	34.41	10.84	20.53	8.57
Trunk.													
Back	.33	.39	.51	.23	.19	.18	1.94	.10	.12	.27	.17	.31	.59
Vertebræ	1.14	......	.97	......	......	1.39	......	......	......	......	......	......	[1]
Thorax	12.72	22.78	14.05	4.22	2.44	.17	3.76	.09	5.57	9.60	4.97	22.83	6.73
Abdomen	5.72	3.97	2.95	.06	1.54	2.81	1.85	......	.03	.04	1.65	6.12	3.30
Groin	.11	.10	.05	.22	.06	.06	.06	.16	.05	.15	.19	.14	.16
Pelvis	2.31	......	2.04	3.91	.03	1.38	[1]	......	......	.19	.84	2.08	.73
Generative organs	.01	......	.02	......	[1]	.01	.05	......	......	......	.01	.01	.01
Total	22.34	27.24	20.59	8.64	4.26	6.00	7.66	.35	5.77	10.25	7.83	31.49	11.52
Upper extremities.													
Scapula	......	......	......	[1]	.03	......	......	......	......	......	.01	......	[1]
Clavicle	.03	.04	.06	......	.02	.04	[1]	......	.04	.02	.03	.03	.01
Shoulder	.09	.15	1.06	.03	.14	.07	.05	.04	.03	.07	.14	.16	.10
Humerus	......	......	.08	.01	.01	[1]	......	......	.11	......	.04	.11	.25
Upper arm	[1]	[1]	.02	.03	.50	.01	......	.05	.06	3.18	.02	1.55	.53
Elbow	.04	.02	.06	.03	.03	.05	.01	.06	.03	.20	.11	.04	.06
Ulna	.02	......	.02	......	.02	.03	.03	......	.04	.08	.02	.05	.02
Radius	.01	.02	.06	.06	.03	.01	.07	......	.02	.06	.04	.06	.03
Ulna and radius	.01	.24	......	......	.03	.04	......	......	.04	......	.03	.02	.02
Forearm	.12	.10	.16	.11	.05	.20	.14	.62	.12	.04	.12	1.41	.18
Wrist	.08	.12	.12	.21	.07	.11	.04	.24	.06	.27	.17	.09	.16
Hand	1.71	.47	1.41	2.28	1.83	.64	2.60	.67	.30	2.20	1.07	.47	1.08
Both hands	.09	.10	.36	.08	.07	.01	.01	.03	......	.07	.02	.02	.02
1 finger	1.45	2.10	2.34	2.60	1.47	1.40	1.49	2.76	4.49	1.38	2.90	2.58	1.81
2 fingers	.37	.08	.41	.38	.63	.13	.35	.99	.72	1.82	.50	.69	.40
3 fingers	.02	.73	.02	.01	.50	.06	[1]	.02	.37	.01	.17	.03	.20
4 fingers	.34	......	......	......	.01	.41	......	1.01	[1]	......	.01	......	.31
Thumb	.41	.87	.96	1.33	.59	1.12	1.01	.19	1.16	.12	1.39	1.04	.99
Thumb and 1 finger	.23	......	[1]	......	......	......	.44	......	......	.01	.33	[1]	.01
Thumb and 2 fingers	......	......	.24	[1]	.18	......	......	......	......	......	.21	......	[1]
Total	5.02	5.04	7.38	7.16	6.21	4.33	6.24	6.68	7.59	9.53	7.33	8.35	6.18

[1] Less than 0.005.

71087°—22——9

TABLE 39.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915, TO 1919, BY LOCATION OF INJURY—Concluded.

Location of injury.	Blast furnaces.	Bessemer.	Open hearth.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Lower extremities.													
Hip	0.02	0.04	0.06	0.01	0.04	0.03	0.05	0.01	0.04	0.03	0.03	0.02	0.03
Femur	1.32	.39	1.17	.03	1.30	.14	.14	......	.26	.02	.07	1.49	.60
Upper leg	2.89	3.87	3.16	3.53	2.87	.44	.11	.06	.09	.09	1.35	5.68	1.09
Knee	.91	.34	.13	.13	.11	.09	.15	.31	.23	.08	.20	.21	.49
Tibia	.13	3.74	.04	.10	.02	.02	.04	.06	.06	......	.07	.09	.07
Fibula	.01	.05	.03	.03	.07	.06	.02	.06	.18	.05	.07	.05	.03
Tibia and fibula	.13	.22	.19	2.02	.44	.63	.16	.36	......	.40	.50	.24	.48
Lower leg	.21	.73	1.42	.65	.99	.36	.24	.28	1.51	.18	.20	2.55	1.92
Ankle	.74	.29	.62	.50	.31	.28	.08	.99	.19	.44	.33	.46	.28
Foot	1.30	1.18	2.66	1.38	1.70	1.92	.72	1.28	2.64	1.00	2.05	8.55	2.39
Both feet	.10	......	1.01	.07	.02	.05	.01	.01	......	......	.01	(1)	.02
Great toe	.33	.96	.59	.85	.67	.84	.19	.19	.85	.17	.51	.60	.72
Great toe and other toes	.07	.05	.07	.09	.09	.22	.10	......	.14	.03	.04	.31	.02
Other toes	.01	.04	.07	(1)	.12	.02	.23	......	......	......	.01	.13	.07
Total	8.17	11.90	11.22	9.39	8.75	5.10	2.24	3.61	6.19	2.49	5.44	20.47	8.21
Unclassified	22.83	18.35	10.91	1.96	3.70	2.73	1.79	(1)	3.60	19.12	2.44	6.15	5.14
Grand total	85.25	68.25	62.55	34.38	30.43	24.08	26.57	11.98	30.58	75.77	33.85	86.99	39.62

[1] Less than 0.005.

On consideration of this table it becomes immediately evident that injuries of various sorts to the thorax are of very serious importance. It has been shown elsewhere that many of these are crushing injuries sustained in connection with vehicles and falling bodies. The following departments have notably high rates for injuries to the thorax: Yards (22.83 days per 10,000 hours' exposure); Bessemer department (22.78 days); open hearths (14.05 days); blast furnaces (12.72 days); electrical (9.60 days).

In a number of departments injuries to the skull are also very serious. They are: Blast furnaces (17.43 days); electrical (14.44 days); yards (8.15 days). When the totals for such regions as the head, trunk, and the extremities are considered, it becomes evident that on the whole injuries to the head are the most serious. In 4 out of 13 departments these injuries stand at the head of the list. The departments in which injuries to the head are thus most serious are the following: Electrical (34.41 days); blast furnaces (26.90 days); mechanical (10.84 days); and tube mills (8.63 days).

Injuries to the trunk are most serious in 5 out of the 13 departments, as follows: Yards (31.49 days); Bessemer department (27.24 days); open hearths (20.59 days); unclassified (11.52 days); plate mills (6.00 days).

When upper and lower extremities are considered, injuries to the lower extremities show the greatest severity in 8 out of the 13 departments. When the number of injuries is considered, those to the upper extremities are very much more numerous; but the proportion of those which give prolonged disability or even result in death is greater for the lower extremities.

In some departments injuries which can not be classified by specific part of the body injured are of very considerable importance;

for example, in blast furnaces (22.83 days), electrical (19.12 days), Bessemer (18.35 days), and open hearths (10.91 days). These are quite largely cases in which extensive general burns have occurred. In blast furnaces they also include the effects of asphyxiating gas.

LOCATION AND NATURE OF INJURY.

Table 40 shows for the usual list of departments the relation between the location and the nature of the injury. It has been thought desirable in presenting this subject to simplify considerably the classification by location.

TABLE 40.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY.

BLAST FURNACES.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.50	(1)	(1)	0.01	0.04	(1)	(1)
Bruise	.07	1.43	0.07	.12	.90	0.41	(1)
Cut	(1)	......	......	......	......	......	......
Laceration	2.40	(1)	.02	.58	.07	.04	......
Puncture	.35	......	.01	.12	.01	.03	......
Burn or scald	2.70	4.69	.08	.21	1.30	.56	9.13
Concussion	1.14	......	.07	......	......	......	......
Dislocation	......	......	.02	.01	.01	(1)	......
Fracture	17.42	4.64	.11	.50	2.47	.87	......
Sprain or strain (not hernia)	......	.10	.01	.02	.03	.12	......
Accidental dismemberment	1.14	......	......	1.68	......	......	......
Nervous shock	......	......	......	......	......	......	(1)
Abrasion with infection	.02	......	.01	.01	.01	......	......
Cut with infection	......	......	......	.57	......	......	......
Laceration with infection	(1)	......	......	.03	.02	......	......
Puncture with infection	......	......	......	.03	......	......	......
Burn or scald with infection	......	......	(1)	(1)	......	(1)	......
Fracture with infection	(1)	.01	......	......	......	......	......
Hernia	......	.09	......	......	......	......	......
Asphyxia	......	.01	......	......	......	......	10.28
Electric flash	.01	(1)	......	.06	......	......	......
Crushing injury	1.14	11.35	......	.74	.76	.51	1.14
Electric shock	......	......	......	......	......	......	1.14
Loss of teeth	.01	......	......	......	......	......	......
Unclassified	(1)	......	......	......	......	(1)	1.14
Total	26.90	22.32	.32	4.71	5.63	2.55	22.83

OPEN HEARTHS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.10	0.01	0.01	0.02	0.02	0.01	......
Bruise	.31	1.27	.05	.23	.33	.68	......
Cut	......	(1)	......	(1)	......	......	......
Laceration	.73	.02	.04	.85	.15	.31	......
Puncture	.15	......	(1)	.04	.01	.04	......
Burn or scald	1.23	2.38	.15	.54	1.21	.57	10.89
Concussion	.01	......	......	......	......	......	......
Dislocation	......	......	.01	(1)	(1)	......	......
Fracture	7.85	4.09	.26	1.00	1.47	1.59	......
Sprain or strain (not hernia)	(1)	.14	.02	.02	.04	.21	......
Accidental dismemberment	......	......	......	1.29	......	.10	......
Nervous shock	(1)	......	......	......	......	......	(1)
Abrasion with infection	.01	......	.97	.09	.02	(1)	......
Laceration with infection	(1)	......	......	.03	.01	(1)	......
Puncture with infection	......	......	......	.01	......	......	......
Burn or scald with infection	......	......	......	.01	.01	......	......
Hernia	......	.08	......	......	......	......	......
Asphyxia	......	......	......	......	......	......	.01
Electric flash	.01	......	......	......	......	......	......
Crushing injury	1.95	12.67	......	1.73	2.92	1.50	......
Heat exhaustion	......	......	......	......	......	......	.01
Electric shock	......	......	......	......	......	......	(1)
Unclassified	(1)	......	......	......	......	......	......
Total	12.36	20.66	1.52	5.87	6.21	5.01	10.91

[1] Less than 0.005.

TABLE 40.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY—Continued.

FOUNDRIES.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.83	[1]	[1]	0.05	0.05	0.05	
Bruise	.03	0.19	0.09	.59	.45	.94	0.01
Laceration	.24		.02	2.29	.22	.34	
Puncture	[1]	[1]	.01	.06	.04	.09	
Burn or scald	2.18	2.09	.03	.17	.01	.58	1.96
Dislocation			[1]			[1]	
Fracture	3.93	.01	.01	2.07	3.75	.71	
Sprain or strain (not hernia)		.18	.03	.10	.01	.10	
Accidental dismemberment				.20			
Abrasion with infection	.01			.31		.02	
Laceration with infection				.02			
Puncture with infection				.01			
Burn or scald with infection						.01	
Hernia		.22					
Asphyxia							[1]
Electric flash	.01						
Crushing injury		5.87		.92	1.96	.06	
Heat exhaustion							[1]
Total	7.23	8.64	.27	6.90	6.49	2.89	1.97

HEAVY ROLLING MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.07	[1]	[1]	0.01	0.02	[1]	
Bruise	.08	0.19	0.04	.14	.25	0.38	[1]
Laceration	.71	.02	.01	.48	.13	.27	
Puncture	.57		[1]	.01	.01	[1]	
Burn or scald	2.03	.12	.02	.14	.03	.22	2.95
Concussion	.75						
Dislocation			[1]	.02	.01	[1]	
Fracture	.85	.07	.26	2.24	2.62	.95	[1]
Sprain or strain (not hernia)	[1]	.14	.51	.02	.06	.11	
Accidental dismemberment				.81		.15	
Nervous shock						.04	[1]
Abrasion with infection	.01			.02	.01		
Laceration with infection	.22			[1]	.74	[1]	
Puncture with infection		[1]		[1]			
Burn or scald with infection	[1]			[1]		[1]	
Fracture with infection				.04	.01		
Hernia		.03					
Asphyxia							[1]
Electric flash	.01						
Crushing injury	2.21	3.69		1.41	1.97	.79	.74
Heat exhaustion							[1]
Loss of teeth	[1]						
Unclassified	.01			[1]			[1]
Total	7.52	4.26	.84	5.35	5.84	2.91	3.70

PLATE MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.11		[1]	0.01	0.03	0.01	
Bruise	.04	1.59	0.08	.14	.34	.61	[1]
Cut	[1]				.01		
Laceration	.15	.02	.15	1.28	.25	.48	
Puncture	[1]	[1]	.01	.07	.04	.05	
Burn or scald	1.46	1.39	.03	.09	.10	.15	
Concussion	[1]						
Dislocation			.02	.01			
Fracture	4.12	2.82	.14	.40	.99	.64	
Sprain or strain (not hernia)	[1]	.11	.02	.03	.02	.10	
Accidental dismemberment				1.16		.20	
Nervous shock				.07			
Abrasion with infection	.01			.01	[1]		
Cut with infection	[1]						
Laceration with infection				[1]	[1]		
Puncture with infection				.03			
Burn or scald with infection						[1]	
Hernia		.06					
Asphyxia	[1]						
Electric flash	.01						
Crushing injury				.59		1.09	
Heat exhaustion							2.73
Loss of teeth	.01						
Total	5.92	6.00	.44	3.88	1.78	3.34	2.73

[1] Less than 0.005.

TABLE 40.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY—Continued.

TUBE MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.09	0.01	0.01	0.05	[1]	0.01	
Bruise	.07	3.74	.02	.05	0.15	.21	0.01
Cut				.02			
Laceration	2.41	.05	.07	.55	.09	.22	
Puncture	.09			.02	.02	.01	
Burn or scald	1.84	.01	.02	.08	.20	.04	
Concussion	1.78						
Dislocation				[1]		.01	
Fracture	.04	.11	.14	.69	.43	.32	[1]
Sprain or strain (not hernia)		.11	.02	.01	.02	.01	
Accidental dismemberment	.53			.71			
Abrasion with infection	.01		.01	1.78			
Laceration with infection		.03		.01	[1]		
Puncture with infection				[1]			
Burn or scald with infection				[1]			
Hernia		.05					
Electric flash	.01						
Crushing injury	1.78	3.55		1.98		.51	
Heat exhaustion							1.78
Unclassified			[1]				[1]
Total	8.62	7.66	.30	5.95	.92	1.33	1.79

SHEET ROLLING MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.06					[1]	
Bruise	.02	0.02	0.02	0.30	0.21	0.53	
Laceration	.14	.02	.58	1.12	.33	.90	[1]
Puncture			[1]	.02		.04	
Burn or scald	.04	.02	.11	.07	.03	.02	
Concussion	.02						
Dislocation				.04			
Fracture	.02	.03		.26	.47	.39	
Sprain or strain (not hernia)		.14	.05	.02	.06	.58	
Accidental dismemberment	1.01			3.39			
Abrasion with infection				.08		.01	
Laceration with infection			.02	.22			
Hernia		.14					
Crushing injury				.38	.02		
Total	1.32	.36	.77	5.92	1.13	2.47	[1]

FABRICATION.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.29			0.01	0.01		
Bruise	.08	0.14	0.09	.19	1.53	0.40	
Laceration	.93	[1]	.07	1.25	.10	.30	
Puncture	.61	.01	[1]	.02	.04	.04	
Burn or scald	.08		.01	.02	.02	.03	1.80
Dislocation				.11	.01	[1]	
Fracture	5.45	.10	.27	1.36	.59	.86	
Sprain or strain (not hernia)		.07	.03	.05	.05	.09	[1]
Accidental dismemberment				1.04			
Abrasion with infection	.01			.02	.01		
Cut with infection				[1]			
Laceration with infection				.10	.02		
Burn or scald with infection				.01			
Hernia		.05					
Asphyxia							[1]
Electric flash	[1]						
Crushing injury		5.40		2.93		2.10	
Loss of teeth	[1]						
Unclassified				.01			1.80
Total	7.44	5.77	.48	7.11	2.37	3.83	3.60

[1] Less than 0.005.

TABLE 40.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY—Continued.

ELECTRICAL.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.12			(1)	0.03		
Bruise	.02	0.27	0.05	0.17	.13	0.18	
Laceration	.26			1.02	.08	.19	
Puncture			.01		.01	.05	
Burn or scald	5.02	.05	.02	.42	.11	.15	4.77
Dislocation			.02	(1)			
Fracture	24.04	.19	.31	.23	.47	.49	
Sprain or strain (not hernia)		.10	.04	.02	.01	.35	
Accidental dismemberment				1.07			
Abrasion with infection	(1)			.07			
Laceration with infection			(1)	.05			
Puncture with infection			.01	.25			
Hernia		.10					
Asphyxia							4.78
Electric flash	.13						
Crushing injury		9.54	3.18	2.56		.24	
Heat exhaustion							.02
Electric shock	4.77						9.55
Loss of teeth	.05						
Total	34.40	10.24	3.65	5.86	.84	1.64	19.12

MECHANICAL.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.12		0.01	0.01	0.01	0.01	
Bruise	.30	0.15	.14	.27	.26	.60	
Cut				(1)			
Laceration	1.18	.02	.05	.81	.10	.13	
Puncture	1.25	.81	.01	.04	.02	.06	
Burn or scald	.93	.01	.04	.10	.04	.09	
Concussion	.01						
Dislocation	(1)		.06	.01	.01	.01	
Fracture	4.88	.88	.21	1.53	.77	1.39	
Sprain or strain (not hernia)	(1)	.12	.03	.02	.08	.12	
Accidental dismemberment				2.11		.04	
Nervous shock		(1)					0.81
Abrasion with infection	.40		.01	.03	.05	(1)	
Laceration with infection	.81			.83	(1)		
Puncture with infection				.01		(1)	
Burn or scald with infection				(1)	(1)		
Hernia		.18					
Asphyxia							.82
Electric flash	.01						
Crushing injury	.81	5.66	.01	.98	1.16	.50	
Heat exhaustion							(1)
Electric shock							.81
Loss of teeth	(1)						
Frosted				.01			
Unclassified							(1)
Total	10.83	7.82	.56	6.77	2.48	2.96	2.44

[1] Less than 0.005.

TABLE 40.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY—Concluded.

YARDS.

Nature of injury.	Head and neck.	Trunk.	Arms.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.12	2.04	(1)	0.01	0.03	0.02	0.01
Bruise	.06	.31	0.08	.26	.44	.78	
Laceration	3.25		.02	.70	.10	.45	
Puncture	.02	4.07		.03	.01	.05	
Burn or scald	.08	.07	.01	.04	.04	.09	2.04
Concussion	(1)						
Dislocation			.07	.01		.03	
Fracture	8.15	2.24	1.84	.95	2.03	1.13	
Sprain or strain (not hernia)		.15	.03	.06	.15	.17	
Accidental dismemberment	2.04			1.08	2.04	.81	
Nervous shock		(1)					
Abrasion with infection	.63		(1)	.03			(1)
Laceration with infection	.02				(1)		
Puncture with infection				.02			
Fracture with infection						2.04	
Hernia		.14					
Asphyxia							(1)
Electric flash	(1)						
Crushing injury	6.09	22.36	1.35	1.73	5.48	4.56	4.06
Heat exhaustion							(1)
Electric shock							.02
Unclassified	(1)						
Total	20.46	31.38	3.41	4.92	10.32	10.11	6.13

UNCLASSIFIED.

Nature of injury.	Head and neck.	Trunk.	Arms.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.
Abrasion	0.33		(1)	0.03	0.02	(1)	
Bruise	.10	0.62	0.11	.28	.28	0.72	
Cut	(1)					(1)	
Laceration	.63	.02	.07	.90	.48	.28	(1)
Puncture	.90	.73	(1)	.05	.02	.04	
Burn or scald	.23	.80	.07	.09	.09	.46	2.90
Concussion	.36						
Dislocation			.04	.02	(1)	.01	
Fracture	4.40	2.23	.63	.47	1.02	.63	(1)
Sprain or strain (not hernia)	(1)	.15	.04	.07	.04	.12	
Accidental dismemberment	.36		.48	1.70	.60	.34	.02
Nervous shock	.01						(1)
Abrasion with infection	.12		(1)	.04	(1)	(1)	
Cut with infection				(1)			
Laceration with infection	.36		(1)	.02	(1)	(1)	
Puncture with infection				.01		(1)	
Burn or scald	.06		(1)	.01	(1)	.01	
Hernia		.13					
Asphyxia							1.81
Electric flash	.01						
Crushing injury	.72	6.48		1.29	1.92	.89	.36
Heat exhaustion							.01
Frosted				(1)		(1)	
Unclassified	(1)	.36	(1)		(1)		.03
Total	8.57	11.52	1.45	4.97	4.54	3.50	5.14

[1] Less than 0.005.

The conspicuous feature of this table in each of the departments is the importance of fractures and crushing injuries, and it becomes evident that fractures of the skull are the important element in giving rise to the high severity of injuries to the head. Crushing injuries affecting the trunk are usually next in order to fractures affecting the skull.

The serious importance of asphyxiating gas in the blast furnace department is again emphasized by this table. In the blast furnace department fractures of the skull have a severity of 17.42 days per 10,000 hours' exposure, while asphyxia has a severity of 10.28 days. It is, therefore, among the most serious injuries from which workers in the blast furnaces suffer and, as indicated elsewhere, it undoubtedly contributes to injuries which are classified under other heads.

LOCATION AND RESULT OF INJURY.

Table 41 presents the facts for the several departments regarding the results arising from injuries to different parts of the body.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY.

BLAST FURNACES.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	20.43	21.57	....	2.27	22.70	66.97
Permanent disability: Loss of—						
Both eyes	1.14	....	....	....	....	1.14
1 hand	....	....	1.14	....	....	1.14
1 leg	....	....	....	2.36	....	2.36
1 foot	....	....	....	.45	....	.45
1 eye	3.23	....	....	....	....	3.23
1 thumb	....	....	.23	....	....	.23
1 finger	....	....	.62	....	....	.62
2 fingers	....	....	.43	....	....	.43
3 fingers	....	....	.37	....	....	.37
4 fingers	....	....	.34	....	....	.34
Thumb and 1 finger	....	....	.23	....	....	.23
Thumb and 3 fingers	....	....	.38	....	....	.38
Great toe	....	....	....	.11	....	.11
Any 2 toes	....	....	....	.06	....	.06
All other	1.14	....	....	....	....	1.14
Total	5.50	....	3.72	2.99	....	12.22
Temporary disability, terminating in—						
1st week	.20	.07	.17	.20	.03	.66
2d week	.17	.10	.21	.27	.02	.77
3d week	.14	.09	.23	.29	.01	.76
4th week	.08	.08	.14	.26	(1)	.56
5th week	.10	.06	.18	.29	....	.62
6th-13th week	.17	.17	.48	.51	.01	1.34
14th week and later	.10	.19	.22	.78	.05	1.34
Total	.97	.75	1.63	2.59	.12	6.06
Grand total	26.90	22.32	5.35	7.85	22.83	85.25

[1] Less than 0.005.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

OPEN HEARTHS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	9.74	19.49	0.97	4.87	10.72	45.80
Permanent disability: Loss of—						
Both legs				.97		.97
1 arm			.65			.65
1 hand			.24			.24
1 foot				1.25		1.25
1 eye	1.36					1.36
1 thumb			.83			.83
1 finger			1.32			1.32
2 fingers			.36			.37
3 fingers			.19			.19
4 fingers			.05			.05
Thumb and 2 fingers			.24			.24
Thumb and 4 fingers			.05			.05
Great toe				.10		.10
Any 2 toes				.10		.10
Total	1.36		3.94	2.42		7.72
Temporary disability, terminating in—						
1st week	.26	.10	.26	.33	.02	.96
2d week	.17	.13	.32	.35	.01	.98
3d week	.20	.12	.36	.42	(1)	1.11
4th week	.11	.11	.28	.34		.85
5th week	.08	.10	.32	.37	(1)	.88
6th-13th week	.32	.32	.67	1.15		2.46
14th week and later	.12	.29	.38	.97	.04	1.81
Total	1.25	1.17	2.60	3.93	.07	9.03
Grand total	12.36	20.66	7.51	11.22	10.79	62.55

FOUNDRIES.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	5.87	7.83		3.91	1.96	19.57
Permanent disability: Loss of—						
1 hand			0.98			.98
1 leg				1.30		1.30
1 eye	.59					.59
1 thumb			.98			.98
1 finger			1.08			1.08
2 fingers			.24			.24
3 fingers			.39			.39
Thumb and 4 fingers			.78			.78
Great toe				.10		.10
Any 2 toes				.10		.10
Total	.59		4.45	1.50		6.54
Temporary disability, terminating in—						
1st week	.28	.07	.33	.28	(1)	.96
2d week	.17	.10	.47	.48		1.21
3d week	.10	.06	.34	.40	.01	.91
4th week	.04	.08	.34	.42		.89
5th week	.04	.10	.23	.33		.69
6th-13th week	.10	.24	.83	1.28		2.45
14th week and later	.04	.17	.19	.78		1.18
Total	.77	.81	2.72	3.97	.01	8.28
Grand total	7.23	8.64	7.17	9.38	1.97	34.38

[1] Less than 0.005.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

HEAVY ROLLING MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	5.16	3.69		3.69	3.69	16.22
Permanent disability: Loss of—						
1 arm			0.59			.59
1 hand			1.38			1.38
1 leg				1.03		1.03
1 foot				.97		.97
1 eye	1.66					1.66
1 thumb			.41			.41
1 finger			1.09			1.09
2 fingers			.64			.64
3 fingers			.44			.44
Thumb and 2 fingers			.18			.18
Great toe				.40		.40
Any 2 toes				.11		.11
Total	1.66		4.73	2.52		8.91
Temporary disability, terminating in—						
1st week	.10	.05	.12	.21	(1)	.49
2d week	.07	.05	.17	.20	(1)	.49
3d week	.07	.04	.16	.18	(1)	.45
4th week	.04	.04	.14	.21	(1)	.44
5th week	.04	.04	.13	.25		.46
6th-13th week	.24	.17	.45	.70		1.56
14th week and later	.14	.18	.29	.81		1.41
Total	.70	.57	1.46	2.55	.01	5.30
Grand total	7.52	4.26	6.19	8.75	3.70	30.43

PLATE MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	5.44	5.44			2.72	13.60
Permanent disability: Loss of—						
1 foot				1.50		1.50
1 thumb			0.95			.95
1 finger			.88			.88
Thumb and 3 fingers			.41			.41
Great toe				.20		.20
Any 2 toes				.20		.20
Total			2.24	1.90		4.15
Temporary disability, terminating in—						
1st week	.11	.07	.21	.37	.01	.78
2d week	.08	.07	.29	.34	(1)	.79
3d week	.07	.06	.23	.32	(1)	.68
4th week	.05	.05	.19	.31		.60
5th week	.01	.03	.15	.33		.52
6th-13th week	.07	.17	.71	.84		1.78
14th week and later	.09	.10	.30	.71		1.20
Total	.48	.56	2.08	3.21	.01	6.34
Grand total	5.92	6.00	4.32	5.11	2.73	24.08

1 Less than 0.005.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

TUBE MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	5.33	7.10	1.78	....	1.78	15.98
Permanent disability: Loss of—						
Both eyes	1.78	....	....	....	....	1.78
1 eye	1.07	....	....	....	....	1.07
1 thumb	....	....	.89	....	....	.89
1 finger	....	....	1.24	....	....	1.24
2 fingers	....	....	.89	....	....	.89
Thumb and 2 fingers	....	....	.44	....	....	.44
Any 2 toes	....	....	....	0.18	....	.18
Total	2.84	....	3.46	.18	....	6.48
Temporary disability, terminating in—						
1st week	.06	.03	.08	.07	.01	.24
2d week	.09	.06	.16	.14	.01	.45
3d week	.05	.04	.13	.15	.01	.37
4th week	.04	.09	.13	.12	....	.38
5th week	.04	.01	.12	.12	....	.29
6th-13th week	.11	.20	.39	.26	....	.96
14th week and later	.07	.13	.23	1.00	....	1.42
Total	.46	.55	1.23	1.85	.02	4.11
Grand total	8.63	7.66	6.47	2.03	1.79	26.57

SHEET MILLS.

Death	....	....	....	....	....	....
Permanent disability: Loss of—						
1 eye	1.01	....	....	....	....	1.01
1 thumb	....	....	0.17	....	....	.17
1 finger	....	....	1.86	....	....	1.86
2 fingers	....	....	.84	....	....	.84
4 fingers	....	....	1.01	....	....	1.01
Total	1.01	....	3.89	....	....	4.90
Temporary disability, terminating in—						
1st week	.06	0.04	.27	0.30	(1)	.67
2d week	.08	.05	.63	.42	....	1.19
3d week	.06	.02	.47	.46	....	1.01
4th week	.02	.05	.43	.27	....	.77
5th week	....	.09	.29	.20	....	.58
6th-13th week	.10	.11	.55	1.25	....	2.00
14th week and later	....	....	.16	.70	....	.87
Total	.31	.36	2.80	3.60	(1)	7.08
Grand total	1.32	.36	6.69	3.60	(1)	11.98

[1] Less than 0.005.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

FABRICATING.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	5.40	5.40		1.80	3.60	16.20
Permanent disability: Loss of—						
1 leg				1.20		1.20
1 eye	1.08					1.08
1 thumb			0.90			.90
1 finger			3.06			3.06
2 fingers			.68			.68
3 fingers			.36			.36
Great toe				.18		.18
Any 2 toes				.18		.18
Total	1.08		5.00	1.56		7.64
Temporary disability, terminating in—						
1st week	.39	.05	.29	.25	(1)	.98
2d week	.21	.06	.53	.49		1.29
3d week	.08	.04	.52	.36		1.00
4th week	.04	.02	.30	.27		.62
5th week	.05	.06	.22	.25		.57
6th-13th week	.12	.12	.51	.64		1.39
14th week and later	.07	.03	.23	.57		.89
All other				.01		.01
Total	.96	.37	2.59	2.83	(1)	6.75
Grand total	7.44	5.77	7.58	6.19	3.60	30.58

ELECTRICAL.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	28.63	9.54			19.09	57.27
Permanent disability: Loss of—						
Both eyes	4.77					4.77
1 arm			3.18			3.18
1 finger			.95			.95
2 fingers			1.79			1.79
Thumb and 3 fingers			1.59			1.59
Great toe				0.24		.24
Total	4.77		7.52	.24		12.53
Temporary disability, terminating in—						
1st week	.24	.04	.18	.18	.01	.66
2d week	.06	.03	.34	.19	.01	.64
3d week	.10	.04	.34	.16		.64
4th week	.10	.06	.18	.11		.43
5th week	.05	.05	.20	.22		.52
6th-13th week	.37	.28	.59	.93		2.17
14th week and later	.08	.19	.17	.45		.90
Total	1.00	.70	2.00	2.24	.03	5.97
Grand total	34.41	10.24	9.52	2.48	19.12	75.77

1 Less than 0.005.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

MECHANICAL.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	7.27	7.27	0.81	0.81	2.42	18.58
Permanent disability: Loss of—						
1 hand			.80			.81
1 leg				1.08		1.08
1 foot				.64		.64
1 eye	2.80					2.80
1 thumb			.81			.81
1 finger			1.49			1.49
2 fingers			.40			.40
3 fingers			.16			.16
Thumb and 1 finger			.32			.32
Thumb and 2 fingers			.20			.20
Great toe				.12		.12
Total	2.80		4.20	1.85		8.85
Temporary disability, terminating in—						
1st week	.23	.07	.23	.25	.01	.78
2d week	.12	.06	.34	.26	(1)	.78
3d week	.08	.04	.32	.27	(1)	.71
4th week	.06	.06	.28	.28		.68
5th week	.07	.06	.24	.20		.56
6th-13th week	.16	.15	.71	.78		1.80
14th week and later	.03	.11	.29	.66		1.10
Total	.76	.55	2.40	2.70	.01	6.42
Grand total	10.83	7.82	7.41	5.35	2.44	33.85

YARDS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	16.29	30.55		8.15	6.11	61.10
Permanent disability: Loss of—						
1 arm			2.89			2.89
1 leg				2.72		2.72
1 foot				4.89		4.89
1 eye	3.67					3.67
1 thumb			.81			.81
1 finger			1.93			1.93
2 fingers			.51			.51
Great toe				.10		.10
Any 2 toes				.20		.20
Total	3.67		6.14	7.91		17.72
Temporary disability, terminating in—						
1st week	.16	.07	.21	.29	.01	.73
2d week	.09	.08	.20	.35	(1)	.72
3d week	.06	.11	.23	.31		.71
4th week	.03	.09	.24	.32		.67
5th week	.02	.06	.21	.40	.01	.70
6th-13th week	.20	.32	.82	1.35	.02	2.71
14th week and later		.20	.42	1.31		1.92
Total	.56	.92	2.31	4.33	.04	8.17
Grand total	20.52	31.48	8.46	20.39	6.15	86.99

1 Less than 0.005.

TABLE 41.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Concluded.

UNCLASSIFIED.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	6.12	10.80		2.52	5.04	24.49
Permanent disability: Loss of—						
1 arm			0.99			.99
1 hand			.45			.45
1 leg				1.50		1.50
1 foot				.72		.72
1 eye	1.75					1.75
1 thumb			.77			.77
1 finger			1.07			1.07
2 fingers			.36			.36
3 fingers			.14			.14
4 fingers			.32			.32
Great toe				.04		.04
Any 2 toes				.11		.11
Other					.02	.02
Total	1.75		4.12	2.36	.02	8.25
Temporary disability, terminating in—						
1st week	.14	.08	.26	.30	.01	.79
2d week	.10	.10	.35	.33	.01	.89
3d week	.10	.07	.35	.38	.01	.91
4th week	.05	.07	.27	.26	.01	.66
5th week	.04	.09	.27	.27	(1)	.67
6th-13th week	.13	.22	.63	.83	.03	1.85
14th week and later	.14	.10	.18	.68	.01	1.12
Total	.70	.72	2.32	3.06	.08	6.88
Grand total	8.57	11.52	6.44	7.95	5.14	39.62

1 Less than 0.005.

An inspection of this table will show from a different standpoint the fact already indicated with regard to the relative seriousness of head injuries as compared with injuries to other parts of the body. Among head injuries which appear constantly with a considerable degree of severity are those involving loss or injury to the eyes. In several of the departments, as for example blast furnaces, mechanical, and yards, this sort of injury stands near the head among permanent disabilities. This is a matter which deserves repeated emphasis in view of the fact that injuries to the eye may be almost entirely eliminated by the use of adequate head and eye protection.

DEPARTMENTS AND NATURE OF INJURY.

Table 42 shows for the several departments the distribution of the severity of injury among the different varieties of bodily damage.

TABLE 42.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS [1] IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE OF INJURY.

Nature of injury.	Blast furnaces.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Abrasion	0.55	0.17	0.99	0.11	0.15	0.17	0.06	0.31	0.15	0.30	2.23	0.38
Bruise	3.00	2.88	2.31	1.07	2.80	4.24	1.11	2.43	.81	1.73	1.94	2.10
Cut	(2)	(2)	......	......	.01	.02	......	(2)	......	(2)	......	(2)
Laceration	3.13	2.10	3.10	1.62	2.33	3.39	3.09	2.65	1.54	2.30	4.53	2.37
Puncture	.51	.23	.21	.59	.17	.14	.06	.72	.07	2.18	4.19	1.74
Burn or scald	18.67	16.97	7.01	5.51	3.22	2.19	.30	1.95	10.54	1.20	2.38	4.64
Concussion	1.14	.01	......	.75	(2)	1.78	.02	......	......	.01	(2)	.36
Dislocation	.05	.02	.01	.03	.03	.01	.04	.12	.03	.09	.10	.07
Fracture	26.01	16.26	10.62	6.99	9.10	1.74	1.17	8.63	25.72	9.63	16.39	9.38
Sprain or strain (not hernia)	.28	.45	.42	.84	.28	.16	.84	.30	.51	.36	.56	.41
Accidental dismemberment	2.82	1.39	.30	.96	1.37	1.24	4.41	1.04	1.07	2.15	5.97	3.50
Nervous shock	(2)	(2)	......	.04	.07	......	......	......	......	.81	(2)	.01
Abrasion with infection	.05	1.10	.33	.04	.02	1.80	.09	.03	.08	.49	.67	.16
Cut with infection	.57	......	......	......	(2)	......	......	(2)	......	......	......	(2)
Laceration with infection	.06	.05	.02	.97	.01	.05	.24	.12	.05	1.65	.02	.39
Puncture with infection	.03	.01	.01	(2)	.03	(2)	......	......	.26	.01	.02	.01
Burn or scald with infection	.01	.01	.01	.01	(2)	(2)	......	.01	......	(2)	......	.07
Fracture with infection	.01	......	......	.05	......	......	......	......	......	......	2.04	......
Hernia	.09	.08	.22	.03	.06	.05	.14	.05	.10	.18	.14	.13
Asphyxia	10.29	.01	(2)	(2)	(2)	......	......	(2)	4.78	.82	(2)	1.81
Electric flash	.07	.01	.01	.01	.01	.01	......	(2)	.13	.01	(2)	.01
Crushing injury	15.63	20.77	8.80	10.80	1.67	7.82	.40	10.43	15.53	9.12	45.77	11.67
Heat exhaustion	......	.01	(2)	.01	2.73	1.78	......	......	.02	(2)	(2)	.01
Electric shock	1.14	(2)	......	......	......	......	......	......	14.32	.81	.02	......
Loss of teeth	.01	......	......	(2)	.01	......	......	(2)	.05	(2)	......	......
Frosted	......	......	......	......	......	......	......	......	......	.01	......	(2)
Unclassified	1.15	(2)	......	.01	......	.01	......	1.81	......	(2)	(2)	.40
Total	85.25	62.55	34.38	30.43	24.08	26.57	11.98	30.58	75.77	33.85	86.99	39.62

[1] The Bessemer department is omitted because the exposure is not sufficient to give satisfactory rates.
[2] Less than 0.005.

The blast furnaces show the greatest severity (26.01 days per 10,000 hours' exposure) for fractures, followed closely by the electrical department (25.72 days). Crushing injury is most conspicuous in the yards (45.77 days). The reason for this is readily understood when it is remembered that the duties of the yard employees require them to work about and among moving cars on the railways.

As would naturally be expected in those departments which have to do with heated metal, burns and scalds are of marked importance, as, for example, in blast furnaces (18.67 days), open hearths (16.97 days), and the electrical department (10.54 days).

NATURE AND RESULT OF INJURY.

Table 43 shows what is the final result, whether death, permanent disability, or temporary disability, arising from the various sorts of injuries.

TABLE 43.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY.

BLAST FURNACES.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All other.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						0.34				0.34	0.21	0.55
Bruise	1.14				0.76					.76	1.11	3.00
Cut											[1]	[1]
Laceration	1.14					1.02	0.20			1.22	.77	3.13
Puncture						.34	.06			.40	.13	.51
Burn or scald	14.76	1.14				1.19				2.33	1.59	18.67
Concussion									1.14	1.14	[1]	1.14
Dislocation											.05	.05
Fracture	22.70				.85	.34	.49	0.06		1.74	1.57	26.01
Sprain or strain (not hernia)											.28	.28
Accidental dismemberment	1.14						1.62	.06		1.67	.01	2.82
Nervous shock											[1]	[1]
Abrasion with infection											.05	.05
Cut with infection							.57			.57		.57
Laceration with infection											.06	.06
Puncture with infection											.03	.03
Burn or scald with infection											.01	.01
Fracture with infection											.01	.01
Hernia											.09	.09
Asphyxia	10.22										.07	10.29
Electric flash										.06	.07	.07
Crushing injury	13.62				.76		.74	.51		2.01	.01	15.63
Electric shock	1.14											1.14
Loss of teeth											.01	.01
Other	1.14										.01	1.15
Total	66.97	1.14			2.36	3.23	3.66	.62	1.14	12.16	6.12	85.25

OPEN HEARTHS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All other.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											0.17	0.17
Bruise	0.97					0.19				0.19	1.71	2.88
Cut											[1]	[1]
Laceration						.44				.44	1.66	2.10
Puncture						.15				.15	.09	.23
Burn or scald	13.64					.58	0.37			.95	2.37	16.97
Concussion											.01	.01
Dislocation											.02	.02
Fracture	12.67						.56	0.86		1.42	2.18	16.26
Sprain or strain (not hernia)											.45	.45
Accidental dismemberment							1.29	.10		1.39		1.39
Nervous shock											[1]	[1]
Abrasion with infection	.97						.05			.05	.08	1.10
Laceration with infection											.05	.05
Puncture with infection											.01	.01
Burn or scald with infection											.01	.01
Hernia											.08	.08
Asphyxia											.01	.01
Electric flash											.01	.01
Crushing injury	17.54		0.97	0.65			1.02	.49		3.13	.10	20.77
Heat exhaustion											.01	.01
Electric shock											[1]	[1]
Other											[1]	[1]
Total	45.80		.97	.65		1.36	3.29	1.44		7.72	9.03	62.55

[1] Less than 0.005.

TABLE 43.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Continued.

FOUNDRIES.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All other.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						0.59				0.59	0.40	0.99
Bruise											2.31	2.31
Laceration							1.47	0.10		1.57	1.54	3.10
Puncture											.21	.21
Burn or scald	5.87										1.14	7.01
Dislocation											.01	.01
Fracture	5.87				1.30		1.52	.10		2.92	1.83	10.62
Sprain or strain (not hernia)											.42	.42
Accidental dismemberment							.29			.29	.01	.30
Abrasion with infection							.29			.29	.04	.33
Laceration with infection											.02	.02
Puncture with infection											.01	.01
Burn or scald with infection											.01	.01
Hernia											.22	.22
Asphyxia											(1)	(1)
Electric flash											.01	.01
Crushing injury	7.83						.88			.88	.10	8.80
Heat exhaustion											(1)	(1)
Total	19.57				1.30	.59	4.45	.20		6.54	8.28	34.38

HEAVY ROLLING MILLS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All other.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											0.11	0.11
Bruise											1.07	1.07
Laceration					0.05	0.44	0.04	0.04		0.57	1.05	1.62
Puncture						.55				.55	.03	.59
Burn or scald	4.42					.44				.44	.64	5.51
Concussion	.74										.01	.75
Dislocation											.03	.03
Fracture	2.21			0.10	.49		1.87	.49		2.95	1.83	6.99
Sprain or strain (not hernia)				.49						.49	.35	.84
Accidental dismemberment							.81	.15		.96		.96
Nervous shock										.04		.04
Abrasion with infection											.04	.04
Laceration with infection	.74					.22				.22	.01	.97
Puncture with infection											(1)	(1)
Burn or scald with infection											.01	.01
Fracture with infection							.04			.04	.01	.05
Hernia											.03	.03
Asphyxia											(1)	(1)
Electric flash											.01	.01
Crushing injury	8.11				.49		1.38	.77		2.65	.04	10.80
Heat exhaustion											.01	.01
Loss of teeth											(1)	(1)
Other											.01	.01
Total	16.22			.59	1.03	1.66	4.14	1.49		8.87	5.34	30.43

[1] Less than 0.005.

TABLE 43.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Continued.

PLATE MILLS.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All other.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion											0.15	0.15
Bruise	1.36										1.44	2.80
Cut											.01	.01
Laceration							0.41	0.07		0.48	1.86	2.33
Puncture											.17	.17
Burn or scald	2.72										.50	3.22
Concussion											(1)	(1)
Dislocation											.03	.03
Fracture	6.80						.07	.61		.68	1.62	9.10
Sprain or strain (not hernia)											.28	.28
Accidental dismemberment							1.16	.20		1.36	.01	1.37
Nervous shock											.07	.07
Abrasion with infection											.02	.02
Cut with infection											(1)	(1)
Laceration with infection											.01	.01
Puncture with infection											.03	.03
Burn or scald with infection											(1)	(1)
Hernia											.06	.06
Asphyxia											(1)	(1)
Electric flash											.01	.01
Crushing injury							.54	1.02		1.56	.11	1.67
Heat exhaustion	2.72										.01	2.73
Loss of teeth											.01	.01
Total	13.60						2.17	1.90		4.08	6.41	24.08

TUBE MILLS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All other.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											0.17	0.17
Bruise	3.55										.69	4.24
Cut											.02	.02
Laceration		1.78				0.53	0.18			2.49	.91	3.39
Puncture											.14	.14
Burn or scald	1.78										.41	2.19
Concussion	1.78											1.78
Dislocation											.01	.01
Fracture							.40			.40	1.33	1.74
Sprain or strain (not hernia)											.16	.16
Accidental dismemberment						.53	.71			1.24		1.24
Abrasion with infection	1.78										.02	1.80
Laceration with infection											.05	.05
Puncture with infection											(1)	(1)
Burn or scald with infection											(1)	(1)
Hernia											.05	.05
Electric flash											.01	.01
Crushing injury	5.32						2.17	0.18		2.35	.14	7.82
Heat exhaustion	1.78										(1)	1.78
Other											.01	.01
Total	15.98	1.78				1.07	3.46	.18		6.48	4.11	26.57

SHEET ROLLING MILLS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All other.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											0.06	0.06
Bruise											1.11	1.11
Laceration											3.09	3.09
Puncture											.06	.06
Burn or scald											.30	.30
Concussion											.02	02
Dislocation											.04	.04
Fracture											1.17	1.17
Sprain or strain (not hernia)											.84	.84
Accidental dismemberment						1.01	3.38			4.39	.02	4.41
Abrasion with infection											.09	.09
Laceration with infection							.17			.17	.07	.24
Hernia											.14	.14
Crushing injury							.34			.34	.06	.40
Total						1.01	3.89			4.90	7.08	11.98

1 Less than 0.005.

TABLE 43.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Continued.

FABRICATING.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All other.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion											0.31	0.31
Bruise					1.20					1.20	1.23	2.43
Cut											[1]	[1]
Laceration						0.54	0.27			.81	1.84	2.65
Puncture						.54				.54	.18	.72
Burns or scalds	1.80										.15	1.95
Dislocation							.09			.09	.03	.12
Fracture	5.40						.63	0.09		.72	2.50	8.63
Sprain or strain (not hernia)											.30	.30
Accidental dismemberment							1.04			1.04		1.04
Abrasion with infection											.03	.03
Cut with infection											[1]	[1]
Laceration with infection							.09			.09	.03	.12
Burn or scald with infection											.01	.01
Hernia											.05	.05
Asphyxia											[1]	[1]
Electric flash											[1]	[1]
Crushing injury	7.20						2.88	.27		3.15	.08	10.43
Loss of teeth											[1]	[1]
Other	1.80										.01	1.81
Total	16.20				1.20	1.08	5.00	.36		7.64	6.75	30.58

ELECTRICAL.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All other.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											0.15	0.15
Bruise											.81	.81
Laceration							0.60			0.60	.95	1.54
Puncture											.07	.07
Burn or scald	4.77	4.77								4.77	1.00	10.54
Dislocation											.03	.03
Fracture	23.86										1.86	25.72
Sprain or strain (not hernia)											.51	.51
Accidental dismemberment							1.07			1.07		1.07
Abrasion with infection											.08	.08
Laceration with infection											.05	.05
Puncture with infection							.24			.24	.02	.26
Hernia											.10	.10
Asphyxia	4.77										.01	4.78
Electric flash											.13	.13
Crushing injury	9.54			3.18			2.43	0.24		5.85	.14	15.53
Heat exhaustion											.02	.02
Electric shock	14.32										[1]	14.32
Loss of teeth											.05	.05
Total	57.27	4.77		3.18			4.33	.24		12.53	5.98	75.77

[1] Less than 0.005.

TABLE 43.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Continued.

MECHANICAL.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All other.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						0.06				0.06	0.24	0.30
Bruise						.24				.24	1.48	1.73
Cut											(1)	(1)
Laceration						.92	0.08			1.00	1.30	2.30
Puncture	0.81					1.21				1.21	.16	2.18
Burn or scald	.81										.39	1.20
Concussion											.01	.01
Dislocation											.09	.09
Fracture	6.46						.71	0.65		1.35	1.81	9.63
Sprain or strain (not hernia)											.36	.36
Accidental dismemberment							2.14			2.14	.01	2.15
Nervous shock	.81										(1)	.81
Abrasion with infection						.36				.36	.13	.49
Laceration with infection	1.62										.03	1.65
Puncture with infection											.01	.01
Burn or scald with infection											(1)	(1)
Hernia											.18	.18
Asphyxia	.81										.01	.82
Electric flash											.01	.01
Crushing injury	6.46				1.08		1.27	.12		2.47	.18	9.12
Heat exhaustion											(1)	(1)
Electric shock	.81											.81
Loss of teeth											(1)	(1)
Frosted											.01	.01
Other											(1)	(1)
Total	18.58				1.08	2.80	4.20	.77		8.85	6.42	33.85

YARDS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All other.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion	2.04										0.19	2.23
Bruise											1.94	1.94
Laceration						3.06				3.06	1.48	4.53
Puncture	4.08										.12	4.19
Burn or scald	2.04										.35	2.38
Concussion											(1)	(1)
Dislocation											.10	.10
Fracture	10.18			1.53	1.36		0.41	0.10		3.39	2.81	16.39
Sprain or strain (not hernia)											.56	.56
Accidental dismemberment	4.08						1.07	.81		1.88	.01	5.97
Nervous shock											(1)	(1)
Abrasion with infection						.61				.61	.06	.67
Laceration with infection											.02	.02
Puncture with infection											.02	.02
Fracture with infection	2.04											2.04
Hernia											.14	.14
Asphyxia											(1)	(1)
Electric flash											(1)	(1)
Crushing injury	36.66			1.36	1.36		1.78	4.28		8.78	.33	45.77
Heat exhaustion											(1)	(1)
Electric shock											.02	.02
Other											(1)	(1)
Total	61.10			2.89	2.72	3.67	3.26	5.19		17.72	8.17	86.99

[1] Less than 0.005.

TABLE 43.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Concluded.

UNCLASSIFIED.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All other.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						0.22				0.22	0.16	0.38
Bruise	0.36										1.74	2.10
Cut											[1]	[1]
Laceration	3.60					.43	0.05		0.02	.50	1.50	2.37
Puncture	.72					.88	.02			.90	.12	1.74
Burn or scald	.36					.06		0.29		.35	.67	4.64
Concussion	.36										[1]	.36
Dislocation											.07	.07
Fracture	6.48			0.51	0.54		.13			1.18	1.73	9.38
Sprain or strain (not hernia)											.41	.41
Accidental dismemberment	.72			.48	.24		1.70	.34		2.76	.02	3.50
Nervous shock											.01	.01
Abrasion with infection						.11				.11	.05	.16
Cut with infection											[1]	[1]
Laceration with infection	.36										.03	.39
Puncture with infection											.01	.01
Burn or scald with infection						.05				.05	.02	.07
Hernia											.13	.13
Asphyxia	1.80										.01	1.81
Electric flash											.01	.01
Crushing injury	9.36				.72		1.22	.23		2.18	.13	11.67
Heat exhaustion											.01	.01
Frosted											[1]	[1]
Other	.36										.04	.40
Total	24.49			1.00	1.50	1.75	3.12	.86	.02	8.25	6.88	39.62

[1] Less than 0.005.

The highest death severity is due to fractures in a majority of the departments, and most of them show a closely approximating severity for crushing injury.

A study of this table reenforces what has already been said with regard to injuries of the eye as a quite serious matter.

In this and other tables pertaining to nature of injury it appears that injuries complicated by infection are of comparatively small importance. It should be stated that infection was not considered unless it was evidently sufficient to prolong the disability or to give rise to certain permanent disabilities which would not have occurred without infection. This showing of the relative absence of infection is highly creditable to the medical service of the concerns covered by this study, and represents a very great advance over the conditions which prevailed earlier.

RESULTS OF INJURY BY YEARS AND DEPARTMENTS.

Table 44 presents, for such plants as reported in a form which could be readily used for the purpose, the frequency and severity of accidents in accordance with their results.

TABLE 44.—ACCIDENT FREQUENCY AND SEVERITY RATES IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY.

FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE).

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	3.87	3.54	2.50	3.18	4.24	3.59	3.05
Permanent total disability:							
Loss of—							
Both arms	.01	(1)	....	.02	....	....	....
Both legs	.01	.03	....	.04	.02	....	.01
Both hands	(1)	(1)	....	....	.01	....	....
Both feet	.01	.01	....	....	.01	.01	.01
Both eyes	.02	.01	....	.04	.02	.01	.01
All other	....	.02	....	....	.02	.03	.04
Total	.05	.07	....	.10	.08	.05	.07
Permanent partial disability:							
Loss or disability of—							
1 arm	.17	.13	.03	.20	.15	.12	.11
1 hand	.25	.24	.17	.22	.24	.30	.23
1 leg	.27	.20	.11	.16	.24	.24	.17
1 foot	.33	.30	.17	.10	.39	.37	.25
1 eye	1.22	1.07	.95	1.20	1.10	1.27	.68
1 thumb	1.06	.80	.80	.86	.88	.84	.56
1 finger	6.37	3.98	3.93	6.08	4.32	3.99	1.99
2 fingers	....	.38	....	....	.44	.55	.47
3 fingers	....	.13	....	....	.09	.22	.19
4 fingers	....	.05	....	....	.07	.06	.07
Thumb and 1 finger	....	.03	....	....	.03	.05	.03
Thumb and 2 fingers	....	.01	....	....	.02	.01	.03
Thumb and 3 fingers	....	.01	....	....	.01	.02	.03
Thumb and 4 fingers	....	.02	....	....	.02	.02	.03
Great toe	.44	.29	.23	.34	.37	.31	.09
Any 2 toes	.62	.35	.52	.56	.43	.24	.16
Other	2.15	1.97	3.84	4.74	1.40	1.64	.68
Total	12.88	9.96	10.75	14.46	10.20	10.25	5.77
Total, permanent disability	12.93	10.03	10.75	14.56	10.28	10.30	5.84
Temporary disability, terminating in—							
1st week	300.59	210.26	205.06	188.22	235.75	210.18	185.53
2d week	125.92	80.97	78.58	91.85	95.74	73.31	62.53
3d week	55.57	38.62	38.29	44.71	43.71	35.77	30.83
4th week	30.22	23.65	21.77	28.36	27.58	21.99	17.49
5th week	18.52	15.39	12.99	18.74	17.87	13.77	12.71
6th-13th week	32.22	27.62	25.84	33.24	31.33	24.75	23.08
14th week or later	6.91	5.49	5.13	7.66	6.64	4.72	3.54
All other	5.50	4.06	.20	.36	4.60	7.16	2.54
Total	575.45	406.08	387.87	413.14	463.22	391.65	338.25
Grand total	592.25	419.63	401.12	430.88	477.74	405.54	347.14
Number of workers	*1,310,911*	*1,335,305*	*168,224*	*166,646*	*410,852*	*392,260*	*249,323*

[1] Less than 0.005.

TABLE 44.—ACCIDENT FREQUENCY AND SEVERITY RATES IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Concluded.

SEVERITY RATES (PER 10,000 HOURS' EXPOSURE).

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	23.25	21.27	14.97	19.08	25.46	21.57	18.29
Permanent total disability:							
Loss of—							
Both arms	.05	.01	....	.12	....	....	....
Both legs	.03	.09	....	.24	.15	....	.08
Both hands	.02	.01	....	....	.05	....	....
Both feet	.05	.04	....	....	.05	.05	.08
Both eyes	.15	.09	....	.24	.10	.05	.08
All other	....	.13	....	....	.15	.15	.24
Total	.30	.39	....	.60	.50	.25	.48
Permanent partial disability:							
Loss or disability of—							
1 arm	.67	.52	.11	.80	.62	48	.43
1 hand	.76	.73	.52	.66	.71	.89	.68
1 leg	1.08	.82	.46	.64	.94	.95	.70
1 foot	.79	.72	.41	.24	.93	.88	.61
1 eye	2.19	1.93	1.70	2.16	1.97	2.29	1.23
1 thumb	.63	.48	.48	.52	.53	.50	.34
1 finger	1.91	1.19	1.18	1.82	1.30	1.20	.60
2 fingers	....	.29	....	....	.33	.41	.35
3 fingers	....	.15	....	....	.11	.27	.22
4 fingers	....	.08	....	....	.11	.09	.10
Thumb and 1 finger	....	.04	....	....	.04	.06	.03
Thumb and 2 fingers	....	.02	....	....	.04	.01	.04
Thumb and 3 fingers	....	.02	....	....	.02	.03	.05
Thumb and 4 fingers	....	.04	....	....	.06	.04	.06
Great toe	.13	.09	.07	.10	.11	.09	.03
Any 2 toes	.19	.10	.15	.17	.13	.07	.05
All other	1.07	.98	1.92	2.37	.70	.82	.34
Total	9.42	8.20	7.00	9.48	8.65	9.08	5.86
Total, permanent disability	9.72	8.57	7.00	10.08	9.15	9.33	6.34
Temporary disability, terminating in—							
1st week	1.05	.74	.72	.66	.83	.74	.65
2d week	1.20	.77	.75	.87	.91	.70	.59
3d week	.86	.60	.59	.69	.68	.55	.48
4th week	.65	.51	.47	.61	.59	.47	.38
5th week	.51	.42	.36	.52	.49	.38	.35
6th - 13th week	1.77	1.52	1.42	1.83	1.72	1.36	1.27
14th week or later	.99	.79	.74	1.10	.96	.68	.51
All other	.09	.07	(1)	.01	.08	.12	.04
Total	7.11	5.42	5.05	6.29	6.26	5.00	4.27
Grand total	40.08	35.26	27.02	35.45	40.87	35.90	28.90
Number of workers	*1,310,911*	*1,335,305*	*116,224*	*166,646*	*410,852*	*392,260*	*249,323*

[1] Less than 0.005.

This table presents the combined experience of two 5-year periods and the course of events during the five years of the later period.

A notable feature of this table, perhaps *the* notable feature, is the almost perfect uniformity with which the second 5-year period shows a lower rate than the first. Whatever influences have been at work have been of a kind which has a general effect on the accidents giving rise to the various results.

The influence of the war period, discussed at length in another chapter, is observable here in the rise in rates for each result, culminating in 1916 or 1917, the rates thereafter declining.

There has been considerable discussion regarding the relative importance of losses of parts of the upper extremities as compared with the lower. In the first 5-year period the upper extremities showed a rate of 4.04 days and the lower of 2.27 days per 10,000 hours' exposure. In the second 5-year period the figures are, for the upper extremities 3.58 days and for the lower extremities 1.86 days. This result is manifestly conditioned in part by the adequacy of the time allowances which have been fixed for the various losses. If those assigned to lower extremity injuries are materially too low the disparity is greater than it should be. When, however, all possible allowance is made for this factor, the greater number of upper extremity losses would still make the severity rates for them greater. That is, for a group of men losses of parts of the upper extremities are more serious, while the individual man may be more seriously handicapped by loss of a leg than by loss of an arm.

THE DEPARTMENTS COMPARED.

Table 45 assembles for purposes of comparison the accident frequency and severity rates for the several departments for the second 5-year period.

TABLE 45.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY RESULT OF INJURY.

FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE).

Result of injury.	Blast furnaces.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Sheet-rolling mills.	Tube mills.	Fabricating.	Wire drawing.	Mechanical.	Yards.	Erection of structural steel.
Death	7.1	6.7	3.1	3.9	2.2	1.5	1.6	2.5	0.8	3.0	5.5	20.1
Permanent total disability: Loss of—												
Both arms	(1)	......	......	......	......	......	......	......	......	......	......	......
Both legs	.1	......	......	......	......	......	......	......	......	(1)	......	......
Both hands	......	......	......	......	......	(1)	......	......	......	......	......	......
Both feet	......	(1)	......	.1	......	......	......	......	......	......	......	......
Both eyes	.1	(1)	(1)	......	......	......	......	(1)	......	......	.1	......
All other	(1)	.1	......	......	......	......	......	......	......	(1)	......	......
Permanent partial disability: Loss of—												
1 arm	.2	.1	.1	......	......	.1	(1)	.1	.1	.2	.3	......
1 hand	.1	.2	.2	.6	.3	.3	.2	.2	.1	.2	.6	......
1 leg	.2	.4	.5	.4	.1	.1	......	(1)	.1	.2	.5	1.3
1 foot	.3	.9	.2	.4	.2	.3	(1)	.1	.1	.3	.7	1.3
1 eye	1.1	.8	1.5	.8	.6	.4	.5	.7	3.4	1.2	1.0	2.2
1 thumb	.5	1.1	.8	1.4	1.0	.5	1.0	.8	1.0	.8	.9	1.8
1 finger	2.2	4.4	4.5	5.2	3.6	2.9	4.0	3.7	7.6	4.2	5.5	4.9
2 fingers	.3	.4	.9	.5	.3	.2	.4	(1)	.1	.3	.3	......
3 fingers	.1	.1	.2	.1	.1	(1)	.1	(1)	.2	.2	.3	......
4 fingers	.1	.1	......	......	......	.1	......	......	......	(1)	.1	......
Thumb and 1 finger	(1)	......	......	.1	.1	(1)	(1)	......	......	.1	......	......
Thumb and 2 fingers	(1)	......	......	......	......	(1)	......	......	......	......	......	.4
Thumb and 3 fingers	......	......	(1)	......	......	(1)	......	......	......	(1)	.1	......
Thumb and 4 fingers	(1)	......	......	......	.1	......	(1)	......	......	(1)	.1	......
Great toe	.2	.5	.3	.8	.4	.1	.2	.3	.3	.1	.5	.4
Any 2 toes	.2	.9	.6	.4	.4	.2	.4	.2	.3	.3	.8	......
All other	1.8	2.1	1.2	2.0	1.0	.5	.4	.4	7.2	2.4	4.5	3.1
Total, permanent disability	7.5	12.1	10.8	12.8	8.4	5.7	7.2	6.5	20.5	10.5	16.3	15.6

[1] Less than 0.05.

TABLE 45.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY RESULT OF INJURY—Continued.

FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE)—Continued.

Result of injury.	Blast furnaces.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Sheet-rolling mills.	Tube mills.	Fabricating.	Wire drawing.	Mechanical.	Yards.	Erection of structural steel.
Temporary disability, terminating in—												
1st week	177.9	218.4	360.4	144.1	157.5	151.2	106.8	333.7	221.8	192.7	170.6	371.8
2d week	76.1	89.5	99.6	61.4	64.0	92.8	43.8	104.3	99.6	67.4	67.7	101.2
3d week	37.1	50.4	52.8	31.1	32.7	43.5	21.3	40.8	44.4	29.7	27.8	56.6
4th week	21.1	31.5	32.3	20.0	24.7	21.7	17.0	24.7	25.5	20.1	18.9	35.7
5th week	16.2	24.1	20.5	15.1	16.3	12.6	10.3	14.9	14.6	13.4	12.2	24.5
6th–13th week	25.0	39.6	31.2	25.8	26.5	21.1	17.7	27.7	24.7	24.8	28.7	62.9
14th week and later	5.7	9.4	4.3	7.1	4.4	4.0	3.0	4.8	4.9	4.6	6.3	18.7
All other	2.5	1.8	7.0	1.1	2.3	1.1	.7	.2	.6	1.1	3.1	1.8
Total	361.6	464.7	608.1	305.7	328.4	348.0	220.6	551.1	436.1	353.8	335.3	673.2
Grand total	376.2	483.5	622.0	322.4	339.0	355.2	229.4	564.1	457.4	367.3	357.1	708.8
Number of workers	*123,669*	*72,271*	*80,029*	*62,957*	*30,505*	*121,355*	*71,216*	*77,078*	*51,967*	*137,257*	*47,685*	*7,477*

SEVERITY RATES (PER 10,000 HOURS' EXPOSURE).

Result of injury.	Blast furnaces.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Sheet-rolling mills.	Tube mills.	Fabricating.	Wire drawing.	Mechanical.	Yards.	Erection of structural steel.
Death	42.7	40.4	18.5	23.8	12.9	8.9	9.8	14.8	4.6	18.1	32.7	120.4
Permanent total disability: Loss of—												
Both arms	.2	......	......	......	......	......	......	......	......	......	......	......
Both legs	.5	......	......	......	......	......	......	......	......	.1	......	......
Both hands	......	......	......	......	......	.2	......	......	......	......	......	......
Both feet	......	.3	......	.3	......	......	......	......	......	......	......	......
Both eyes	.3	.3	.2	......	......	......	......	.3	......	......	.4	......
All other	.2	.6	......	......	......	......	......	......	......	.1	......	......
Permanent partial disability: Loss of—												
1 arm	.9	.4	.3	......	......	.4	.2	.3	.3	.8	1.4	......
1 hand	.4	.7	.6	1.9	1.0	.8	.7	.6	.2	.7	1.7	......
1 leg	1.0	1.5	2.0	1.5	.4	.4	......	.2	.3	.7	2.0	5.3
1 foot	.6	1.0	.6	1.0	.5	.7	.1	.2	.2	.7	1.7	3.2
1 eye	2.0	1.5	2.6	1.4	1.2	.6	.9	1.2	6.1	2.1	1.9	4.0
1 thumb	.3	.7	.5	.9	.6	.3	.6	.5	.6	.5	.5	1.1
1 finger	.6	1.3	1.2	1.6	1.1	.9	1.2	1.1	2.3	1.3	1.6	1.5
2 fingers	.2	.3	.7	.4	.2	.2	.3	(1)	(1)	.2	.2	......
3 fingers	.2	.2	.2	.1	.1	(1)	.1	.1	.2	.3	.3	......
4 fingers	.1	.1	......	......	......	.1	......	......	......	(1)	.2	......
Thumb and 1 finger	(1)	......	......	.1	.1	(1)	.1	......	......	.1	......	......
Thumb and 2 fingers	(1)	......	......	......	......	(1)	......	......	......	......	......	.7
Thumb and 3 fingers	......	......	.1	......	......	.1	......	......	......	(1)	.1	......
Thumb and 4 fingers	.1	......	......	......	.3	......	.1	......	......	.1	.2	......
Great toe	(1)	.2	.1	.3	.1	(1)	.1	.1	.1	(1)	.1	.1
Any 2 toes	.1	.3	.2	.1	.1	.1	.1	.1	.1	.1	.2	......
All other	.9	1.0	.6	1.0	.5	.2	.2	.2	3.6	1.2	2.3	1.6
Total, permanent disability	8.6	10.4	9.9	10.6	6.2	5.0	4.7	4.9	14.0	9.0	14.9	17.5

[1] Less than 0.05.

TABLE 45.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY RESULT OF INJURY—Concluded.

SEVERITY RATES (PER 10,000 HOURS' EXPOSURE)—Concluded.

Result of injury.	Blast furnaces.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Sheet rolling mills.	Tube mills.	Fabricating.	Wire drawing.	Mechanical.	Yards.	Erection of structural steel.
Temporary disability, terminating in—												
1st week	0.6	0.8	1.5	0.5	0.6	0.5	0.4	1.2	0.8	0.7	0.6	1.3
2d week	.7	.9	.9	.6	.6	.9	.4	1.0	.9	.6	.6	1.0
3d week	.6	.8	.8	.6	.5	.7	.3	.6	.7	.5	.4	.9
4th week	.5	.7	.7	.4	.5	.5	.4	.5	.5	.4	.4	.8
5th week	.4	.7	.6	.4	.4	.3	.3	.4	.4	.4	.3	.7
6th-13th week	1.4	2.2	1.7	1.4	1.5	.7	1.0	1.5	1.4	1.4	1.4	3.5
14th week and later	.8	1.3	.7	1.0	.6	.6	.4	.7	.7	.7	.9	2.7
All other	(1)	(1)	.1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Total	5.0	7.4	7.0	4.9	4.7	4.2	3.2	5.9	5.4	4.7	4.6	10.9
Grand total	56.3	57.8	35.4	39.3	23.8	18.1	17.7	25.6	24.0	31.3	52.2	148.8
Number of workers	*123,669*	*72,271*	*80,029*	*62,957*	*30,505*	*121,355*	*71,216*	*77,078*	*51,967*	*137,257*	*47,685*	*7,477*

[1] Less than 0.05.

The most cursory examination of this table would undoubtedly impress the observer with the extraordinary rates shown for the erection of structural steel. This is discussed at length elsewhere. It is pertinent here to note that this is due not only to the many deaths but to the fact that in all the results scheduled these workers suffer to an unusual degree.

The main impression arising from close study of the table will be that the different types of industrial activity are not so different in the distribution of their cases among the several forms of result as might be expected. In some departments certain results are clearly characteristic, such as, for example, the loss of an eye and of a finger in wire drawing. The eye losses are due to the tendency of the ends of wire to fly around in a whiplike manner, while fingers are from time to time tangled in the moving strands. Aside from a few such conspicuous instances it would appear that the distribution among the different sorts of result is surprisingly constant at whatever level is characteristic of the department.

A comparison of the frequency and severity rates will show that with great constancy the cases terminating in the first week, while much more numerous than those extending into the second week, are not sufficiently so to equal the longer disability involved in cases running into the second week.

THE DEPARTMENTS IN DETAIL.

Table 46 gives the severity rates for all the important departments by results of injuries. The number of cases involved and frequency rates will be found in Table 8, pages 349 to 354, and Table 11, pages 374 to 384.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
BLAST FURNACES.							
Death	52.0	42.7	35.4	30.9	43.6	56.4	35.4
Permanent disability: Loss of—							
Both arms		.2		1.3			
Both legs		.5			1.1		.7
Both feet	.2						
Both eyes	1.1	.3				.6	.7
1 arm	1.0	.9			.7	1.7	.9
1 hand	1.0	.4		.7	.3	.6	.3
1 leg	1.5	1.0	1.2	.9	.7	1.7	.4
1 foot	.4	.6	.7		1.3	.5	.3
1 eye	2.2	2.0	.6	2.0	2.2	2.6	1.8
1 thumb	.2	.3	.4	.4	.3	.6	
1 finger	1.2	.6	.7	1.0	.8	.5	.4
2 fingers		.2			.1	.2	.6
3 fingers		.2			.2	.4	
4 fingers		.1			.3		
Thumb and 1 finger		(1)					.1
Thumb and 2 fingers		(1)					.2
Thumb and 4 fingers		.1				.3	
Great toe	.1	(1)			.1	.1	
Any 2 toes	.1	.1	.2	.2	(1)	(1)	(1)
All other	1.1	1.1	1.2	3.2	1.0	.3	.9
Total	10.1	8.6	5.0	9.7	9.1	10.1	7.3
Temporary disability, terminating in—							
1st week	1.0	.6	.6	.6	.7	.6	.5
2d week	1.2	.7	.6	.8	.8	.8	.6
3d week	1.0	.6	.5	.7	.7	.6	.4
4th week	.7	.5	.3	.6	.6	.5	.3
5th week	.6	.4	.3	.6	.5	.4	.3
6th-13th week	2.1	1.4	1.1	1.5	1.5	1.6	1.0
14th week and later	1.5	.8	1.0	1.6	.6	1.0	.4
All other	.2	(1)			.1	.1	(1)
Total	8.3	5.0	4.4	6.4	5.5	5.6	3.6
Grand total	70.4	56.3	44.8	47.0	58.2	72.1	46.2
Number of workers	*124,636*	*123,669*	*10,721*	*14,905*	*36,202*	*31,904*	*29,937*
BESSEMER DEPARTMENT.							
Death	39.9	44.5	12.7	63.9	66.9	38.9	25.3
Permanent disability: Loss of—							
1 leg	1.4	1.9		3.3	2.2	3.7	
1 foot	1.1	.7		2.0	1.3		
1 eye	4.5	3.1	1.9	5.9	5.0	1.7	
1 thumb	.9	.6	1.9	.5	.3		.8
1 finger	2.3	1.3	2.2	1.7	1.3	1.7	
2 fingers		.2			.4	.7	
Thumb and 1 finger		.2				1.1	
Great toe	.1	.2	.3	.5		.6	
Any 2 toes	.3	.3	.3	1.0	.2	.3	
All other	1.6	2.1	4.2	5.7	.8	.9	
Total	12.2	10.6	10.8	20.6	11.5	10.7	.8
Temporary disability, terminating in—							
1st week	1.4	.8	.9	1.0	.9	.6	.5
2d week	1.9	1.0	.7	1.4	1.3	1.0	.5
3d week	1.5	1.1	1.0	1.4	1.3	.8	.6
4th week	1.3	1.0	1.0	1.3	1.3	.9	.4
5th week	1.0	.9	1.0	1.1	1.1	.7	.4
6th-13th week	4.0	3.0	2.7	3.9	4.2	2.4	1.6
14th week and later	1.5	1.6	.8	1.8	2.2	1.9	1.1
All other	.1	(1)		(1)	.1	(1)	(1)
Total	12.7	9.4	8.1	11.8	12.4	8.3	5.1
Grand total	64.8	64.5	31.6	96.2	90.8	57.9	31.2
Number of workers	*28,101*	*21,557*	*3,160*	*4,071*	*5,979*	*3,596*	*4,751*

[1] Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

OPEN HEARTHS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	39.6	40.4	26.8	40.2	43.8	51.2	35.8
Permanent disability: Loss of—							
Both feet	.3	.3			.9		
Both eyes		.3		3.4			
1 arm	.9	.4			.6	.6	
1 hand	1.0	.7	1.7			.5	2.1
1 leg	2.4	1.5			.6	1.9	3.7
1 foot	2.0	1.0				2.7	1.1
1 eye	1.2	1.5	2.0	3.0	2.2	.6	1.2
1 thumb	.8	.7	.7	1.0	.7	.8	.6
1 finger	2.4	1.3	.8	2.7	1.6	1.5	.6
2 fingers		.3				1.0	
3 fingers		.2				.6	
4 fingers		.1				.2	.3
Great toe	.2	.2		.3	.1	.3	.1
Any 2 toes	.3	.3	.5	.7	.3	.2	
All other	.9	1.6	2.0	2.2	1.2	2.1	1.5
Total	12.4	10.4	7.7	13.3	8.2	13.0	11.1
Temporary disability, terminating in—							
1st week	1.3	.8	.9	1.2	.8	.8	.7
2d week	1.5	.9	.8	1.5	.9	.9	.6
3d week	1.1	.8	.8	1.5	.8	.8	.5
4th week	1.0	.7	.5	1.2	.8	.8	.4
5th week	.7	.7	.7	1.3	.7	.7	.4
6th-13th week	2.5	2.2	1.7	4.2	2.5	2.2	1.6
14th week and later	1.4	1.3	1.1	2.8	1.7	1.3	.7
All other	.1	(1)	(1)	(1)	(1)	.1	(1)
Total	9.6	7.4	6.5	13.7	8.2	7.6	4.9
Grand total	61.6	57.8	41.0	67.2	60.2	71.8	51.8
Number of workers	*71,293*	*72,271*	*5,969*	*9,654*	*21,457*	*20,681*	*14,510*

FOUNDRIES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	17.5	18.5		16.2	28.3	13.7	8.9
Permanent disability: Loss of—							
Both eyes		.2			.6		
1 arm	.6	.3			.4	.4	
1 hand	.4	.6				.9	1.5
1 leg	.7	2.0			2.1	2.0	2.0
1 foot	1.0	.6			1.0	.5	
1 eye	2.7	2.6			1.9	3.2	3.6
1 thumb	.9	.5		1.6	.6	.4	.3
1 finger	2.2	1.2	0.8	1.6	.9	1.6	1.2
2 fingers		.7			.8	.6	.6
3 fingers		.2			.4		.3
Thumb and 3 fingers		.1					.5
Great toe	.2	.1			.2	.1	
Any 2 toes	.2	.2	.8	1.6	.1	.1	.2
All other	1.5	.6		1.4	.9	.4	.4
Total	10.4	9.9	1.6	6.2	9.9	10.2	10.4
Temporary disability, terminating in—							
1st week	1.3	1.5	.5	.5	1.5	1.2	1.2
2d week	1.0	.9	.5	.8	1.1	.9	.8
3d week	.8	.8	.6	.7	.9	.8	.6
4th week	.6	.7	.7	.8	.7	.7	.6
5th week	.5	.6	.2	.6	.6	.6	.5
6th-13th week	.2	1.7	1.4	3.1	1.8	1.8	1.4
14th week and later	1.3	.7		.8	.8	.4	.6
All other	.1	.1			.2	.1	(1)
Total	5.8	7.0	3.9	7.3	7.6	6.5	5.7
Grand total	33.7	35.4	5.5	20.7	45.8	30.4	25.0
Number of workers	*95,917*	*80,029*	*1,309*	*1,231*	*31,805*	*32,186*	*13,498*

[1] Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

BAR MILLS.[2]

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	....	19.1	6.2	24.8	21.4	34.8	5.3
Permanent disability: Loss of—							
1 arm	....	1.9	4.1	....	1.8	....	3.5
1 hand	....	.5	....	....	1.3	....	....
1 foot	....	.4	....	....	....	2.3	....
1 eye	....	2.0	....	....	3.2	5.2	....
1 thumb	....	.3	....	....	.3	.6	.5
1 finger	....	2.1	1.5	1.9	2.9	3.2	.3
2 fingers	....	.1	....	....	.3	....	....
Great toe	....	[1]	....	....	.1	....	....
Any 2 toes	....	.2	....	....	.4	....	.3
All other	....	.6	.5	2.6	....	....	.4
Total	....	8.1	6.1	4.5	10.3	11.3	5.0
Temporary disability, terminating in—							
1st week	....	1.4	1.2	1.4	1.8	1.3	.8
2d week	....	1.3	.8	1.5	1.5	1.2	.9
3d week	....	1.1	.8	1.3	1.3	.9	.7
4th week	....	.8	.9	1.2	.7	.8	.4
5th week	....	.6	.5	.7	.7	.5	.5
6th-13th week	....	2.4	1.9	3.2	2.5	2.3	1.9
14th week and later	....	.8	.6	1.2	1.2	1.0	....
All other	....	[1]	[1]	....	[1]	.1	....
Total	....	8.4	6.7	10.5	9.7	8.1	5.1
Grand total	....	35.6	19.2	39.8	41.4	54.2	15.4
Number of workers	....	*20,992*	*3,232*	*3,042*	*7,472*	*3,439*	*3,807*

HEAVY ROLLING MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	21.0	23.8	28.0	13.9	29.2	29.0	14.0
Permanent disability: Loss of—							
Both feet	....	.3	....	....	....	1.5	....
1 arm	.6	....	....	....	....	....	....
1 hand	.7	1.9	....	3.0	1.5	3.6	.9
1 leg	1.0	1.5	3.7	2.6	.6	....	2.8
1 foot	1.4	1.0	1.1	.8	.8	1.2	1.9
1 eye	1.5	1.4	.8	1.8	1.8	1.7	.7
1 thumb	.5	.9	.6	1.0	.9	1.3	.5
1 finger	2.1	1.6	1.1	1.9	1.6	2.4	.6
2 fingers	....	.4	....	....	.2	.7	.9
3 fingers	....	.1	....	....	.4	....	....
Thumb and 1 finger	....	.1	....	....	.2	....	....
Great toe	.2	.3	....	.4	.5	.1	....
Any 2 toes	.3	.1	....	....	.3	....	....
All other	.6	1.0	2.3	1.2	.8	1.0	.6
Total	8.9	10.6	9.7	12.6	9.6	13.4	9.4
Temporary disability, terminating in—							
1st week	.8	.5	.5	.5	.4	.6	.8
2d week	.8	.6	.4	.6	.7	.6	.6
3d week	.7	.6	.4	.6	.5	1.0	.5
4th week	.6	.4	.4	.5	.5	.5	.4
5th week	.5	.4	.3	.5	.4	.5	.4
6th-13th week	1.8	1.4	1.0	1.8	1.6	1.3	1.4
14th week and later	1.2	1.0	.7	1.0	1.3	1.1	.9
All other	.1	[1]	[1]	....	[1]	[1]	.1
Total	6.5	4.9	3.8	5.4	5.5	5.5	5.2
Grand total	36.4	39.3	41.5	32.0	44.3	48.0	33.4
Number of workers	*67,663*	*62,957*	*7,148*	*10,076*	*20,530*	*13,788*	*11,415*

[1] Less than 0.05.
[2] Data for 1910-1914 for bar mills not available.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

PLATE MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	17.5	12.9	9.6	12.8	11.8	10.8	18.2
Permanent disability: Loss of—							
Both feet	.9						
1 arm	1.2						
1 hand	1.4	1.0		2.1	1.5	1.1	
1 leg		.4			2.0		
1 foot	1.5	.5			11.8	.9	
1 eye	1.7	1.2		1.3		1.9	1.6
1 thumb	.4	.6	1.9	1.3	.3	.4	.3
1 finger	2.9	1.1	2.4	1.1	1.3	1.1	.7
2 fingers		.2			.4		.7
3 fingers		.1			.6		
Thumb and 1 finger		.1				.4	
Thumb and 4 fingers		.3					1.0
Great toe	.1	.1		.2	.1	.1	.1
Any 2 toes	.3	.1	.5	.2	.1		.1
All other	.8	.5	.8	1.1	1.2		
Total	11.2	6.2	5.6	7.3	8.7	5.9	4.4
Temporary disability, terminating in—							
1st week	.8	.6	.3	.4	.7	.6	.5
2d week	1.0	.6	.4	.7	.7	.6	.6
3d week	.8	.5	.3	.4	.5	.6	.5
4th week	.7	.5	.5	.6	.6	.6	.4
5th week	.5	.4	.3	.6	.5	.5	.4
6th-13th week	3.3	1.5	.8	1.8	1.5	1.6	1.3
14th week and later	1.1	.6		.3	.9	.8	.7
All other	(1)	(1)		(1)		.1	
Total	8.2	4.7	2.6	4.9	5.3	5.4	4.4
Grand total	36.9	23.8	17.8	25.0	25.9	22.0	27.1
Number of workers	*21,711*	*30,505*	*2,086*	*4,681*	*6,764*	*9,302*	*7,672*

PUDDLING MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	14.1	10.5			4.8	22.1	
Permanent disability: Loss of—							
1 arm	1.0						
1 hand	1.6						
1 eye	2.3	2.4			2.9	2.2	
1 thumb	.5	.8			.5	1.4	
1 finger	3.4	.4			.5	.4	
2 fingers		1.0			1.8		
Great toe	.1	.1			.2		
Any 2 toes	.1	.1			.2		
All other	.1						
Total	9.1	4.8			6.2	4.1	
Temporary disability, terminating in—							
1st week	.8	.8			.8	.8	0.5
2d week	.9	.8			.9	.8	.6
3d week	.6	.7			.8	.7	.2
4th week	.4	.5			.4	.7	.5
5th week	.5	.5			.5	.4	.6
6th-13th week	1.4	1.7			1.8	1.8	1.0
14th week and later	.8	.6			.8	.4	.6
All other	.2	.2			.1	.4	.5
Total	8.2	5.8			6.1	5.9	4.6
Grand total	31.3	21.1			17.1	32.1	4.6
Number of workers	*12,788*	*7,600*			*4,129*	*2,712*	*759*

[1] Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

ROD MILLS.[2]

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	...	17.5	...	...	28.3	30.8	9.4
Permanent disability: Loss of—							
1 arm	...	.9	...	...	...	4.1	...
1 foot	...	1.6	...	...	3.2	...	3.7
1 eye	...	3.6	...	4.8	4.8	1.8	5.6
1 thumb	...	.4	...	.8	.4	...	.9
1 finger	...	1.1	0.5	.8	1.6	.6	1.4
3 fingers	...	.3	...	...	...	...	1.9
Great toe	...	.2	.5	...	.2	.3	...
Any 2 toes	...	.2	...	.4	.2	.3	...
All other	...	3.4	6.5	6.7	2.0	2.6	.8
Total	...	11.6	7.4	13.5	12.5	9.7	14.4
Temporary disability, terminating—							
1st week	...	.6	.6	.5	.8	.5	.3
2d week	...	.9	.8	.9	1.1	.9	.5
3d week	...	.5	.6	.6	.6	.7	.3
4th week	...	.6	.3	.6	.8	.5	.5
5th week	...	.3	.5	.3	.4	.5	.1
6th-13th week	...	1.6	2.0	1.5	1.1	1.7	2.4
14th week and later	...	.6	.7	.6	.6	.7	.7
All other	...	(1)	...	...	...	.2	(1)
Total	...	5.3	5.4	4.9	5.4	5.6	4.8
Grand total	...	34.4	12.9	18.4	46.2	46.1	28.6
Number of workers	...	*14,894*	*2,062*	*2,493*	*4,951*	*3,249*	*2,139*

SHEET MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	13.5	8.9	8.6	10.5	12.2	3.5	3.5
Permanent disability: Loss of—							
Both hands	.2	.2	...	...	.4	...	...
1 arm	.6	.4	...	.5	.9	...	...
1 hand	1.1	.8	.6	.8	.7	1.7	.6
1 leg	.6	.4	...	.5	.6	.8	...
1 foot	.4	.7	1.0	.6	.5	.9	.5
1 eye	.7	.6	...	.5	1.3	.7	.7
1 thumb	.5	.3	.4	.5	.3	...	...
1 finger	1.6	.9	.9	1.8	.8	.3	.1
2 fingers	...	.2	...	...	.2	.4	.1
3 fingers	...	(1)	...	...	.1	...	...
4 fingers	...	.1	...	...	.1	...	.3
Thumb and 1 finger	...	(1)	...	...	.1	...	...
Thumb and 2 fingers	...	(1)	...	...	.1	...	...
Thumb and 3 fingers	...	(1)	...	...	.1	...	...
Great toe	.1	(1)	...	(1)	(1)	...	...
Any 2 toes	.1	.1	.1	.1	(1)	...	...
All other	.3	.2	...	...	(1)	...	1.6
Total	6.3	5.0	3.0	5.4	6.4	4.9	3.9
Temporary disability, terminating in—							
1st week	1.0	.5	.6	.5	.6	.3	.5
2d week	1.2	.9	1.0	1.0	1.0	.3	.8
3d week	.6	.7	.7	.8	.7	.3	.7
4th week	.5	.5	.5	.5	.5	.2	.5
5th week	.4	.3	.4	.4	.4	.2	.3
6th-13th week	1.1	.7	1.1	1.4	.1	.6	1.0
14th week and later	.9	.6	.8	.5	.7	.2	.4
All other	(1)	(1)	...	...	(1)	(1)	...
Total	5.7	4.2	5.1	5.2	4.2	2.1	4.1
Grand total	25.4	18.1	16.7	21.2	22.7	10.5	11.5
Number of workers	*128,423*	*121,355*	*16,266*	*24,722*	*46,040*	*17,278*	*17,049*

[1] Less than 0.05.
[2] Data for 1910-1914 for rod mills not available.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS. 1915 TO 1919, BY RESULT OF INJURY—Continued.

TUBE MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	10.1	9.8	5.6	3.5	17.2	8.6	8.3
Permanent disability: Loss of—							
1 arm	.5	.2	......	......	......	......	.9
1 hand	.3	.7	......	......	1.0	.5	1.4
1 leg	.2	......	......	......	......	......	......
1 foot	.2	.1	......	......	.4	......	......
1 eye	.7	.9	.8	1.1	.6	.6	1.7
1 thumb	.9	.6	.6	.5	.8	.5	.4
1 finger	1.8	1.2	1.1	1.5	1.4	1.3	.6
2 fingers	......	.3	......	......	.3	.5	.3
3 fingers	......	.1	......	......		.2	.3
Thumb and 1 finger	......	.1	......	......	......	.2	......
Thumb and 4 fingers	......	.1	......	......	.4	......	......
Great toe	.2	.1	......	.2	.1	.1	......
Any 2 toes	.1	.1	.4	.2	.2	.1	......
All other	1.1	.2	.2	......	.3	.1	.3
Total	6.0	4.7	3.2	3.4	5.3	4.2	5.9
Temporary disability, terminating in—							
1st week	.7	.4	.4	.1	.7	.3	.2
2d week	.9	.4	.4	.3	.6	.4	.3
3d week	.7	.3	.3	.3	.4	.3	.3
4th week	.5	.4	.2	.4	.4	.4	.4
5th week	.4	.3	.3	.3	.3	.2	.3
6th–13th week	1.2	1.0	1.1	1.0	1.2	.9	.8
14th week and later	.6	.4	......	.4	.4	.3	.4
All other	(1)	(1)	......	......	(1)	(1)	(1)
Total	5.0	3.2	2.7	2.7	4.0	2.9	2.7
Grand total	21.0	17.7	11.5	9.7	26.5	15.7	14.7
Number of workers	*73,338*	*71,216*	*7,109*	*11,355*	*19,819*	*18,500*	*14,433*

MISCELLANEOUS ROLLING MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	17.0	10.5	9.2	12.4	8.1	11.0	12.9
Permanent disability: Loss of—							
Both legs	.2	......	......	......	......	......	......
1 arm	1.2	.7	......	1.6	1.1	.5	......
1 hand	.9	.6	......	1.2	1.2	.3	......
1 leg	1.3	.3	......	......	.5	.5	......
1 foot	1.0	.4	......	......	......	.8	.6
1 eye	2.2	1.3	1.4	......	1.7	1.2	1.3
1 thumb	.9	.5	.9	.2	.3	.7	.7
1 finger	1.7	1.1	1.1	2.2	1.0	.9	.9
2 fingers	......	.3	......	......	.4	.3	.2
3 fingers	......	.1	......	......			.6
4 fingers	......	.1	......	......	.2	.2	......
Thumb and 2 fingers	......	.1	......	......	.2	......	......
Great toe	.1	.1	.2	......	(1)	.1	......
Any 2 toes	.2	.1	.2	.1	.2	(1)	......
All other	.7	.1	1.5	.6	.3	.9	......
Total	10.4	6.2	5.3	6.1	7.2	6.5	4.3
Temporary disability, terminating in—							
1st week	1.1	.8	.7	.6	.8	.8	.7
2d week	1.7	.8	.7	.7	1.0	.7	.6
3d week	1.3	.6	.6	.6	.8	.6	.5
4th week	1.0	.5	.4	.6	.7	.4	.3
5th week	.8	.5	.2	.5	.6	.4	.5
6th–13th week	2.4	1.7	1.1	2.2	2.2	1.5	1.4
14th week and later	1.0	.7	.4	1.5	.7	.6	.6
All other	.1	.2	......	(1)	.4	.1	.1
Total	9.4	5.8	4.1	6.2	7.2	5.1	4.8
Grand total	36.8	22.5	18.6	24.7	22.5	22.5	22.0
Number of workers	*98,809*	*80,380*	*4,367*	*8,082*	*24,811*	*29,188*	*13,932*

[1] Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

FABRICATING.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	17.3	14.8	15.7	28.1	18.0	14.4	6.4
Permanent disability: Loss of—							
Both arms	.4	....	....	....	....	....	....
Both eyes	....	.3	....	....	.9	....	....
1 arm	.4	.3	....	....	....	.9	....
1 hand	.6	.6	....	....	.9	.7	.6
1 leg	.9	.2	....	....	....	.5	....
1 foot	.4	.2	....	....	....	.3	.5
1 eye	2.6	1.2	1.6	1.2	1.3	1.4	.8
1 thumb	....	.5	1.0	1.2	.3	.4	.6
1 finger	....	1.1	2.1	3.4	2.0	.3	.3
2 fingers	....	(1)	....	....	....	....	.2
3 fingers	....	.1	....	....	....	....	.3
Great toe	.2	.1	....	.2	(1)	.1	.2
Any 2 toes	.1	.1	.8	....	.1	....	....
All other	.4	.2	.4	1.0	.4	....	.1
Total	6.0	4.9	5.9	7.0	5.7	4.5	3.6
Temporary disability, terminating in—							
1st week	1.6	1.2	.7	.6	1.2	1.3	1.1
2d week	1.5	1.0	.7	1.1	1.1	1.0	.8
3d week	1.0	.6	.5	.9	.8	.5	.5
4th week	.7	.5	.5	.9	.6	.5	.4
5th week	.6	.4	.5	.7	.6	.2	.4
6th-13th week	1.9	1.5	2.1	2.1	1.7	1.4	1.1
14th week and later	.7	.7	1.5	2.2	.6	.5	.5
All other	(1)	(1)	....	....	(1)	....	(1)
Total	8.0	5.9	6.6	8.5	6.6	5.5	4.9
Grand total	31.3	25.6	28.2	43.7	30.3	24.4	14.9
Number of workers	*108,538*	*77,078*	*3,818*	*4,980*	*23,382*	*29,167*	*15,732*

FORGES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	25.6	11.3	....	....	14.7	6.2	32.5
Permanent disability: Loss of—							
Both legs	....	1.9	....	....	7.3	....	....
1 hand	....	.9	....	....	....	1.6	....
1 leg	....	1.3	....	....	4.9	....	....
1 foot	....	1.5	....	....	....	2.5	....
1 eye	1.9	1.7	....	....	4.4	.9	....
1 thumb	1.0	.2	....	....	....	.3	....
1 finger	1.1	1.1	....	....	2.6	.6	.8
2 fingers	....	.7	....	....	1.8	.4	....
3 fingers	....	.4	....	....	....	.6	....
Thumb and 2 fingers	....	.5	....	....	1.8	....	....
Great toe	.2	.1	....	....	.4	....	....
Any 2 toes	.3	....	....	....	....	....	....
All other	1.1	2.4	....	....	....	3.9	....
Total	5.6	12.7	....	....	23.2	10.8	.8
Temporary disability, terminating in—							
1st week	.9	1.0	....	0.2	1.5	.9	.7
2d week	1.6	.9	....	....	1.6	.7	.5
3d week	1.2	.6	....	.3	1.0	.5	.5
4th week	.7	.7	....	....	1.3	.6	.1
5th week	.4	.5	....	1.8	.9	.4	.3
6th-13th week	1.2	1.6	....	....	3.1	1.1	1.0
14th week and later	.6	.6	....	....	1.2	.4	.4
All other	.2	(1)	....	....	....	.1	....
Total	6.8	6.1	....	2.2	10.7	4.7	3.6
Grand total	38.0	30.1	....	2.2	48.5	21.8	36.9
Number of workers	*6,249*	*10,577*	....	*209*	*2,728*	*6,408*	*1,232*

1 Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

WIRE DRAWING.[2]

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	....	4.6	2.5	8.4	4.4	6.3	....
Permanent disability: Loss of—							
1 arm	....	.3	....	1.4	....	....	....
1 hand	....	.2	1.3	....	....	....	....
1 leg	....	.3	....	....	1.0	....	....
1 foot	....	.2	....	8.4	....	....	....
1 eye	....	6.1	7.6	6.9	3.9	7.1	5.9
1 thumb	....	.6	.5	1.0	.6	.6	.2
1 finger	....	2.3	1.8	3.8	2.0	2.3	1.6
2 fingers	....	[1]					.3
3 fingers	....	.2	....	....	....	.3	1.0
Great toe	....	.1	.3	....	.1	.1	.1
Any 2 toes	....	.1	.1	.1	.1	.1	....
All other	....	3.6	6.8	8.6	2.2	1.2	.8
Total	....	14.0	18.4	22.6	9.8	11.6	9.9
Temporary disability, terminating in—							
1st week	....	.8	1.6	1.1	.7	.4	.3
2d week	....	.9	1.5	1.5	.9	.5	.3
3d week	....	.7	1.0	.9	.7	.5	.4
4th week	....	.5	.7	.8	.6	.3	.4
5th week	....	.4	.5	.5	.5	.3	.2
6th-13th week	....	1.4	1.4	1.3	1.3	1.2	1.6
14th week and later	....	.7	.9	.3	1.1	.8	.2
All other	....	[1]	....	[1]	[1]	[1]	[1]
Total	....	5.4	7.6	6.4	5.8	4.2	3.4
Grand total	....	24.0	28.5	37.4	20.0	22.1	13.3
Number of workers	....	*51,967*	*7,859*	*9,551*	*13,727*	*12,757*	*8,073*

ELECTRICAL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	45.8	53.9	32.7	73.4	73.0	26.3	54.8
Permanent disability: Loss of—							
1 arm	3.7	1.0	....	....	....	3.5	....
1 hand	1.4	.8	....	....	....	....	3.9
1 leg	.9	1.0	....	....	3.0	....	....
1 foot	1.1	1.2	....	....	1.8	2.1	....
1 eye	1.7	1.4	....	....	2.7	1.6	....
1 thumb	.3	.2	....	....	.5	....	....
1 finger	1.4	1.3	1.6	3.7	.9	1.3	.4
2 fingers	....	.4	....	....	1.1	....	....
4 fingers	....	.4	....	....	1.1	....	....
Thumb and 1 finger	....	.3	....	....	.9	....	....
Thumb and 3 fingers	....	.5	....	....	....	....	2.6
Great toe	.1	.1	....	....	.2	....	....
Any 2 toes	.4	.1	....	....	.2	....	....
All other	.6	.1	....	....	.4	....	....
Total	11.6	8.8	1.6	3.7	13.0	8.5	6.9
Temporary disability, terminating in—							
1st week	.9	.7	.4	1.2	.8	.6	.6
2d week	.9	.6	.1	.8	.9	.3	.5
3d week	.6	.4	.1	.7	.5	.2	.4
4th week	.4	.3	....	.7	.5	.2	.2
5th week	.3	.4	....	.7	.5	.1	.5
6th-13th week	1.4	1.2	....	1.9	1.7	.6	1.2
14th week and later	.9	1.0	.8	1.8	2.0	.1	.4
All other	[1]	[1]	....	[1]	[1]	....	....
Total	5.4	4.6	1.3	7.9	6.8	2.0	3.8
Grand total	62.8	67.3	35.6	84.9	92.8	36.9	65.5
Number of workers	*14,421*	*12,988*	*612*	*1,636*	*4,385*	*3,801*	*2,555*

[1] Less than 0.05.
[2] Data for 1910-1914 for wire drawing not available.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

MECHANICAL DEPARTMENT.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	21.0	18.1	10.0	10.6	25.8	14.5	23.5
Permanent disability: Loss of—							
Both legs	....	.1	....	1.2	....	....	....
1 arm	.4	.8	....	2.4	1.2	....	1.2
1 hand	.9	.7	....	1.2	1.2	.3	.4
1 leg	.8	.7	....	.8	.4	.9	.6
1 foot	.5	.7	....	....	1.2	.8	.3
1 eye	2.9	2.1	....	3.5	2.0	2.6	.8
1 thumb	.6	.5	.7	.2	.9	.3	.4
1 finger	1.8	1.3	1.7	1.7	2.0	.9	.7
2 fingers	....	.2	....	....	.3	.3	.2
3 fingers	....	.3	....	....	....	.5	.5
4 fingers	....	(1)	....	....	....	.1	....
Thumb and 1 finger	....	.1	....	....	.1	.1	....
Thumb and 3 fingers	....	(1)	....	....	....	.1	....
Thumb and 4 fingers	....	(1)	....	....	....	.1	....
Great toe	.1	(1)	....	.1	(1)	(1)	(1)
Any 2 toes	.2	.1	....	.1	.1	.1	(1)
All other	1.4	1.3	4.2	3.4	.9	.8	1.0
Total	9.6	9.0	6.5	14.6	10.4	6.9	6.1
Temporary disability, terminating in—							
1st week	1.1	.7	.6	.8	.9	.5	.7
2d week	1.3	.6	.6	.8	1.0	.4	.6
3d week	.9	.5	.4	.6	.7	.3	.4
4th week	.7	.4	.3	.6	.7	.3	.4
5th week	.5	.4	.2	.6	.6	.2	.3
6th-13th week	2.0	1.4	1.2	1.7	2.3	.6	1.6
14th week and later	1.2	.7	.6	1.1	1.3	.3	.4
All other	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Total	7.7	4.7	4.0	6.3	7.6	2.6	4.4
Grand total	38.4	31.3	20.5	31.6	43.8	24.0	34.0
Number of workers	*97,162*	*137,257*	*5,987*	*16,920*	*33,328*	*58,003*	*23,019*

POWER DEPARTMENT.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	14.8	19.8	....	....	26.1	35.7	....
Permanent disability: Loss of—							
Both eyes	2.5	....	....	....	....	....	....
1 hand	....	.9	....	....	2.6	....	....
1 leg	3.3	1.2	....	....	3.5	....	....
1 foot	....	.7	....	....	2.1	....	....
1 eye	....	.5	....	....	....	1.8	....
1 thumb	.5	.5	....	8.8	....	....	....
1 finger	1.7	.5	....	....	.3	1.2	....
2 fingers	....	.8	....	1.5	1.3	.7	....
4 fingers	....	.5	....	....	1.3	....	....
Any 2 toes	.1	....	....	....	....	....	....
All other	.2	.6	....	....	....	2.0	....
Total	8.3	6.2	....	10.3	11.0	5.7	....
Temporary disability, terminating in—							
1st week	.4	.2	0.2	.4	.2	.2	0.2
2d week	.4	.3	....	.5	.3	.2	.2
3d week	.4	.2	....	.5	.1	.2	.3
4th week	.2	.2	....	.8	.1	.2	.1
5th week	.2	.2	....	.7	.2	.1	.2
6th-13th week	.8	.7	....	1.6	.7	.5	.9
14th week and later	.5	.4	....	1.4	.6	.3	....
All other	(1)	(1)	....	....	....	(1)	....
Total	2.9	2.2	.2	5.8	2.2	1.7	1.9
Grand total	26.1	28.2	.2	16.1	39.3	43.1	1.9
Number of workers	*8,083*	*11,099*	*195*	*680*	*3,837*	*3,366*	*3,021*

1 Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Continued.

YARDS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	40.0	32.7	....	30.6	45.8	28.1	35.9
Permanent disability: Loss of—							
Both eyes	....	.4	....	2.5	....	....	....
1 arm	.7	1.4	....	3.4	1.7	.8	....
1 hand	.2	1.7	....	....	2.5	2.4	....
1 leg	4.1	2.0	....	....	3.4	.8	6.8
1 foot	1.6	1.7	2.1	....	1.5	1.0	8.2
1 eye	1.5	1.9	1.6	3.1	1.9	1.1	3.1
1 thumb	.7	.5	.5	.8	.8	.2	.5
1 finger	1.9	1.6	.8	2.5	1.7	1.2	2.3
2 fingers	....	.2	....	....	.2	.3	.6
3 fingers	....	.3	....	....	....	.7	1.0
4 fingers	....	.2	....	....	.3	.3	....
Thumb and 3 fingers	....	.1	....	....	....	.4	....
Thumb and 4 fingers	....	.2	....	....	.5	....	....
Great toe	.1	.1	....	.1	.1	.2	.3
Any 2 toes	.3	.2	....	.1	.2	.2	.8
All other	1.5	2.3	3.9	5.1	2.0	1.3	....
Total	12.6	14.9	8.8	17.7	16.8	11.1	23.6
Temporary disability, terminating in—							
1st week	.9	.6	.8	.7	.7	.4	.7
2d week	1.0	.6	.6	.8	.8	.5	.6
3d week	.7	.4	.4	.6	.5	.3	.5
4th week	.5	.4	.4	.4	.4	.4	.5
5th week	.5	.3	.3	.4	.4	.3	.4
6th-13th week	1.8	1.4	1.4	1.8	1.7	1.2	.2
14th week and later	.9	.9	.4	1.1	1.1	.7	1.1
All other	[1]	[1]	....	....	....	....	.1
Total	6.3	4.6	4.2	5.7	5.5	3.8	4.2
Grand total	58.9	52.2	13.0	53.9	68.0	43.0	63.7
Number of workers	*55,932*	*47,685*	*3,843*	*7,853*	*15,732*	*16,355*	*3,902*

COKE.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	40.7	31.0	....	45.6	57.8	24.4	18.4
Permanent disability: Loss of—							
1 arm	4.0	1.1	....	....	2.4	....	2.0
1 hand	.8	.9	....	....	1.8	1.4	....
1 leg	3.0	.6	....	....	....	....	2.0
1 foot	1.8	....	....	....	....	....	....
1 eye	1.8	.5	3.6	2.7	....	....	....
1 thumb	.2	.2	....	....	....	....	.6
1 finger	.7	.7	1.2	.9	.9	.8	.3
2 fingers	....	.2	....	....	.9	....	....
4 fingers	....	.2	....	....	....	.7	....
Great toe	.1	.1	....	.9	....	....	....
Any 2 toes	.2	[1]	....	.5	....	....	....
All other	1.3	.3	1.0	....	.3	.2	.3
Total	13.9	4.8	5.9	5.0	6.3	3.1	5.3
Temporary disability, terminating in—							
1st week	.8	.4	.6	.5	.5	.3	.4
2d week	.7	.5	.3	.2	.6	.6	.4
3d week	.5	.3	.2	.3	.4	.2	.2
4th week	.4	.2	.4	.3	.3	.2	.2
5th week	.5	.2	.3	.2	.2	.2	.2
6th-13th week	1.5	.7	.6	.9	.8	.6	.8
14th week and later	1.1	.6	.3	1.3	.7	.6	.3
All other	.1	[1]	.1	.1	[1]	....	....
Total	5.6	2.9	2.7	3.8	3.5	2.7	2.3
Grand total	60.2	38.7	8.6	54.4	67.6	30.2	26.0
Number of workers	*13,282*	*23,263*	*1,648*	*2,195*	*5,538*	*7,368*	*6,514*

[1] Less than 0.05.

TABLE 46.—ACCIDENT SEVERITY RATES (PER 10,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910–1914 AND 1915–1919, AND BY YEARS 1915 TO 1919, BY RESULT OF INJURY—Concluded.

ERECTION OF STRUCTURAL STEEL.[2]

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	....	181.0	199.3	197.8	207.6	162.1	129.0
Permanent disability: Loss of—							
1 leg	....	5.3	16.6	13.2	....	10.8	....
1 foot	....	3.2	10.0	....	13.8	....	....
1 eye	....	4.0	7.5	....	15.6	4.9	....
1 thumb	....	1.1	2.5	2.0	3.5	....	....
1 finger	....	1.5	2.5	....	5.2	....	3.9
Thumb and 2 fingers	....	.7	....	....	....	4.1	....
Great toe	....	.1	1.2	....	....	....	....
All other	....	1.6	....	1.6	2.9	....	8.6
Total	....	17.5	40.3	16.8	40.9	19.8	12.5
Temporary disability, terminating in—							
1st week	....	1.3	2.1	1.3	2.4	2.1	1.8
2d week	....	1.0	1.5	1.4	1.9	1.2	1.1
3d week	....	.9	1.6	1.1	1.9	1.0	.9
4th week	....	.8	1.9	1.3	1.0	.8	.9
5th week	....	.7	.7	1.5	1.0	.7	1.1
6th-13th week	....	3.5	4.1	4.4	7.0	6.1	3.3
14th week and later	....	2.7	.6	6.2	7.1	2.5	3.1
All other	....	(1)	....	....	....	....	.3
Total	....	10.9	12.4	17.2	22.3	14.2	12.5
Grand total	....	209.4	252.0	231.9	270.9	196.1	154.0
Number of workers	....	*7,477*	*808*	*1,011*	*1,156*	*1,234*	*775*

UNCLASSIFIED.[3]

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	....	14.1	14.9	14.0	18.2	11.5	13.4
Permanent disability: Loss of—							
Both legs	....	.1	....	.9	....	....	....
Both feet	....	.1	....	....	....	....	.4
1 arm	....	.4	....	.6	.6	.3	.3
1 hand	....	.6	1.4	....	.4	.7	.8
1 leg	....	.7	.6	.6	1.2	.8	....
1 foot	....	.6	....	....	.7	.7	.9
1 eye	....	1.6	2.2	.7	1.7	1.9	1.3
1 thumb	....	.3	.2	.2	.4	.4	.3
1 finger	....	1.0	.9	1.4	1.0	1.1	.7
2 fingers	....	.2	....	....	.3	.5	.1
3 fingers	....	.2	....	....	.1	.3	.2
4 fingers	....	.1	....	....	.1	.1	.3
Thumb and 1 finger	....	(1)	....	....	....	(1)	.1
Thumb and 2 fingers	....	(1)	....	....	....	....	.1
Thumb and 4 fingers	....	.1	....	....	.1	....	.2
Great toe	....	.1	....	....	.1	.1	....
Any 2 toes	....	(1)	.1	.1	.1	(1)	(1)
All other	....	1.1	.5	1.9	1.2	1.4	.2
Total	....	7.2	5.9	6.3	8.0	8.3	5.5
Temporary disability, terminating in—							
1st week	....	.6	.8	.6	.7	.5	.6
2d week	....	.6	.8	.8	.8	.5	.6
3d week	....	.5	.7	.6	.5	.4	.5
4th week	....	.4	.5	.5	.5	.4	.4
5th week	....	.3	.4	.3	.3	.3	.3
6th-13th week	....	1.3	1.9	1.8	1.5	1.0	1.3
14th week and later	....	.7	.9	1.1	.9	.6	.5
All other	....	.2	....	(1)	.1	.3	.1
Total	....	4.6	5.9	5.7	5.3	4.0	4.3
Grand total	....	25.9	26.6	26.0	31.5	23.8	23.2
Number of workers	....	*263,791*	*21,547*	*24,216*	*68,130*	*97,513*	*52,385*

[1] Less than 0.05.
[2] Data for 1910–1914 for erection of structural steel not available.
[3] Data for 1910–1914 for unclassified departments not available.

CHAPTER VII.—THE HUMAN FACTORS IN CAUSING AND PREVENTING ACCIDENTS.

In the chapters on the physical causes of accidents the machine, the structure, the impersonal thing directly related to the injury of the worker, have been under review. If these were all the factors in the situation, the problem would be a comparatively simple one. It is a fact, however, that these physical causes are bound up with very complex human factors whose influence must now be considered.

There are three divisions of a working organization which have a very definite relation to this accident problem, namely, the management, the foremen, and the workers. It may seem a far cry from the man of wealth and power who sits in an office in the great metropolis and the ignorant and obscure laborer who, in the process of satisfying the wants of the public, dies. This is far from being the case. The development of business organization is such that the view of the central authority regarding any question quickly penetrates to all parts of the business and influences to a surprising degree the behavior of even the least important element. In nothing is this more true than in the matter of due attention to the safety of workpeople. Rather close observation has failed to note a case where the chief authorities were indifferent and the accident rate was not high, and, on the other hand, it is a rule with no exceptions that an interested and determined management always has its way in the matter of accident prevention.

This factor of the management does not lend itself readily to any statistical treatment and will therefore be dismissed with this passing reference and attention directed to the more immediate factors, the foremen and the workers.

THE FOREMEN.

It has long been agreed that, in the effort to excite personal interest in the maintenance of safe conditions and the exercise on the part of the worker of reasonable personal caution, the foreman is the key to the situation. His contact with the situation is immediate, and he is recognized by the workmen as representing the management, and the fact that he is a foreman usually means that he has personal qualities which command respect.

It is therefore of prime importance that in the matter of accident prevention the foreman have a sympathetic attitude and a clear understanding of what is being attempted.

THE ACCIDENT REDUCTION BONUS.

Various means have been utilized for bringing the foremen into this sympathetic relationship. Originally safety committees were composed almost entirely of foremen, and frequently there were minor distinctions, such as safety buttons, watch fobs, etc., which were bestowed upon the foremen who engaged actively in safety work.

The production bonus is so well established a feature in the iron and steel industry that it is practically everywhere taken for granted. It may be applied in special cases, such as in an effort to break a record, or it may be a constant feature of the operation of the mill. In the latter case some standard production quota is determined upon, and production in excess of this quota is paid for at an advanced price. It is entirely natural, therefore, that safety men should consider the application of a monetary reward as a solution of their problem.

It is noticeable that nearly all of the pioneer safety men entered upon their activities with rather pronounced ideas regarding the type of appeal which ought to be made in the effort to stimulate interest among the men in the safety problem. They, for the most part, stressed the humane motive and regarded the offering of a reward for activity in the safety field as being an unbecoming appeal to the mercenary interests of the men involved.

On the other hand, there were a considerable number of men who began to agitate for the use of an accident-reduction bonus, on the ground that the elimination of accidents was a business proposition and that any device which had proved effective in the ordinary conduct of the business was perfectly appropriate in their particular field. They were also convinced that the humane motive was entirely uninfluenced by the offering of a substantial money consideration for successful safety effort. It was inevitable that somewhere those who held the opinion that the use of a bonus for the purpose of stimulating attention to accident reduction was a worthy device would be in a position to make a test of their ideas, and such tests were made here and there in different establishments.

The question of the effect of these methods can not be judged by these minor and scattered experiments. An effort was therefore made to assemble on a large scale information with regard to the application of the safety bonus and from the statistical showing thus made to determine its precise value. The basic departments of the iron and steel industry, namely, blast furnaces, steel works, and rolling mills, were finally chosen as affording the largest body of data pertaining to operations of a sufficiently similar character for a proper comparison, as it is quite evident that departments in which the character of the work done is very different might be affected very differently by the introduction of a safety bonus.

A careful study was made of the assembled data to make sure that there were no unusual conditions which might render the data of any department incomparable with that of the others and thus influence the result of the experiment. It is believed that the present presentation is as fair and authoritative as it is possible to make.

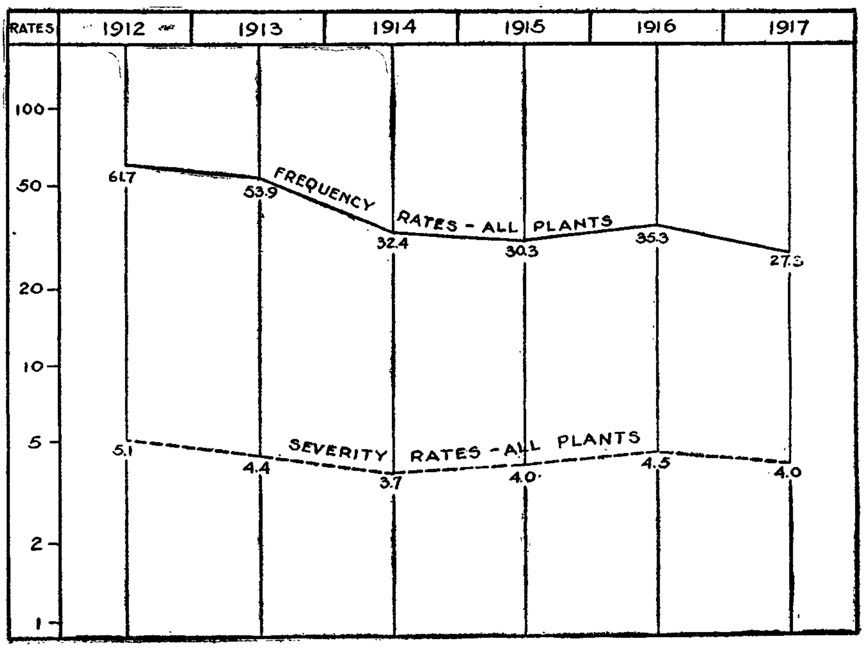
The general significance of this study lies in the possibility which the material afforded of considering the experience from the standpoint both of frequency and of severity of accidents. The relations shown between the frequency rates would have failed to bring out the effect of the use of the bonus.

In the plants whose records are here brought together the details of the bonus plan varied considerably, but the following points are essentially common to them all: (1) From a study of the past experience of the department basing rates were determined which had to be equaled or improved if the foreman was to receive a bonus. (2) Failure to hold accidents down to the basing rate would deprive the foreman of the bonus. If he equaled the basing rate he would receive a certain sum per man under his supervision. The sum awarded the foreman would increase in proportion to the decrease below the basing rate. (3) The designated sum per man under the jurisdiction of the foreman was sufficiently large to make the securing of it worth while. For example, a foreman with 100 men in his crew might, under favorable circumstances, receive $200 or more as his annual bonus.

The statistical results of the study of the application of the safety bonus can best be presented in the form of charts.

Chart 8 shows the accident frequency and severity rates for the entire group of mills, including both bonus and nonbonus plants, over a period of six years. It happens that the frequency and severity rates are so related that they can be plotted on a single percentage

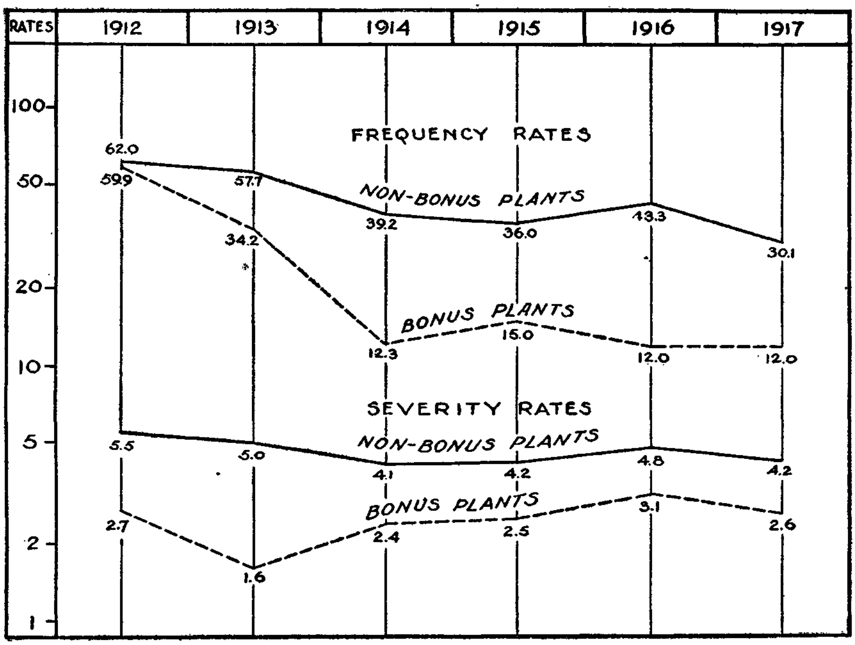
CHART 8.—ACCIDENT RATES FOR A SELECTED GROUP OF MILLS IN THE IRON AND STEEL INDUSTRY, 1912 TO 1917.



scale. The general result is in conformity with all studies thus far made of the experience of the iron and steel industry. From a high point in 1912, both frequency and severity rates decline to 1914 or 1915. There is then a rise to 1916 with a recurrent decline in 1917. The high point of 1916 is not so high as that of 1912.

In Chart 9 accident rates are shown for the bonus and the nonbonus plants of the group represented in the preceding chart. Inspection of this chart shows that the bonus plants, starting at practically the same frequency rates as nonbonus plants, had for two years a very rapid decline in frequency rates—much more rapid than that in the nonbonus plants. Following this decline they maintained a materially lower rate in frequency than did the nonbonus plants. On the other hand, the general trend of severity rates of the bonus plants is upward, while those of the nonbonus plants decline. The general decline in severity rates noted in Chart 8 is entirely due to the influence of the nonbonus group. The bonus group tended to cause the rates to rise. There are undoubtedly many factors involved in this situation and a too broad or too emphatic a statement of the significance of them should be avoided. Personal study of all the plants involved discloses only two points in which the bonus group differs materially from the nonbonus: (1) On the whole the bonus group has a slightly superior physical condition and might be expected, therefore, to have somewhat lower severity rates. (2) In the bonus plants there has existed since 1913 a bonus to the foremen for accident reduction. Most careful and painstaking scrutiny and inquiry have failed to develop any other material differences. Under these circumstances it would seem to be entirely fair to insist that these two factors are mainly responsible in bringing about such differences as appear in

CHART 9.—ACCIDENT RATES FOR BONUS AND NONBONUS PLANTS IN A SELECTED GROUP OF MILLS IN THE IRON AND STEEL INDUSTRY, 1912 TO 1917.



the trend of the accident rates. It is proper to say, in this connection that remarkable decline in frequency rates on the adoption of the foreman bonus is the universal experience. Wherever this method has been tried this result has appeared. It may, therefore, without limitation, be said that such a bonus does tend strongly to the reduction of minor injury.

FOREMEN'S ACTIVITIES.

In a search for the reasons for the changes indicated in the charts the natural appeal is to the foremen themselves. Inquiry has therefore been constantly and systematically made regarding the methods adopted by foremen in their efforts to secure the offered bonus.

The following points appear with entire constancy in the testimony of the foremen: (1) The foremen were convinced by this offer that the company was really and deeply interested in the success of safety effort. "When the company comes across with real money we know that they mean business." That is to say, up to the time of the inauguration of the accident reduction bonus the foremen had been somewhat skeptical regarding the reality of the company's interest in accident prevention. They had felt that the company was interested above all else in production and that the phrase "Safety first" was little more than idle words. (2) Under the old conditions, the foremen had not been in the habit of considering at all carefully the fitness of the man to the particular task which would be required of him. If a slow and heavy man presented himself, the foreman might set him to work in spite of the fact that in such work a certain degree of quickness and agility was the only safeguard against sudden death. The inauguration of the bonus focused the attention of the foremen upon this subject and they proceeded to select men with much greater care and to refuse to hire those obviously unsuited to the work of which they had charge. (3) Besides exercising care in selecting the men the foreman himself took greater pains in instructing new men regarding safe methods of work and would see to it that such a new man was associated with a more experienced worker who would look after the newcomer during the period of his training. It is quite possible that this conversion of the mills into schools of safety may be much the most important factor in the reductions which have come about. (4) The classification of injuries was in accordance with the duration of the disability. Since the longer disability imposed a heavier penalty it became a matter of importance to the foreman to secure the prompt return of the injured man to duty. As prompt a return as reasonably possible is obviously of advantage both to the man himself and to the company. There were, however, two abuses which tended to develop on account of this interest of the foremen in prompt return: (*a*) A man might be brought back and put on duty at a nominal job not having any real and important relation to the operations of the mill. This practice became so marked in one large plant that the superintendent was obliged to issue an order that when a man was returned to duty when not able to resume his original occupation, the foreman must show clearly that the job proposed for him was a real job and one of actual necessity. The presence of men who were there simply to save a foreman's bonus was regarded as tending seriously to lower the morale of the working force. (*b*) Sometimes in his anxiety to save his bonus the foreman would urge men to return to work who were not yet in physical condition for the work. This, of course, is a matter for the control of the medical staff and in most cases their professional pride is a sufficient safeguard against permitting premature return of the injured men. (5) It was not always the case that the foreman had any helpful relations outside the mill with the men under his direction. When it was made a matter of importance to him that an injured man return promptly to work, he was apt to form a friendly acquaintance on the outside with his men and this may have had much to do with securing active cooperation in safety work within the mill.

The response of foremen to the offer of a bonus by the company was for the most part along the lines indicated above. These offers were particularly successful in reducing short-term disabilities due to minor accidents. The degree to which minor accidents may be reduced under a bonus system is very striking.

In earlier studies of the iron and steel industry it has been shown that the percentages of injured who returned to work in successive weeks are about as follows: First week, 50 per cent; second week, 25 per cent; third week, 10 per cent. With the inauguration of the safety movement these percentages for the early weeks steadily declined, falling as low in some cases as 40 and 35 per cent in the first week. In some of the plants having bonus systems this downward tendency of accidents involving less than one week's disability has reached the point where the percentage for the first week is actually less than that for the second week. As one manager stated it: "We have almost abolished short-term disabilities." There is no intrinsic reason why the tendency to eliminate minor injury should not go to this extent but certainly it could not have been anticipated in advance of an experimental test.

This showing is so remarkable that some have been inclined to suggest that it was due to erroneous reporting. It is proper, therefore, to say that every facility has been afforded for checking up the records and there is no indication of imperfection in the matter of reporting cases.

THE RISING SEVERITY RATE.

The trend of severity rates as disclosed in Chart 9 suggests two questions:

(1) Why did the bonus plants have a lower severity rate than the nonbonus? and (2) Why should the severity rate for bonus plants constantly rise when the frequency rate was so conspicuously falling?

In reply to the first question, it is probably the case that the slight superiority of the bonus plants in the matter of engineering revision is sufficient to account for this generally lower severity rate. The fact that severity in the bonus plants, though lower than in the nonbonus, was rising is less easy to explain. It should be emphasized that this phenomena is almost completely constant. It is shown in the three departments chosen for consideration because of their comparability with similar departments in which the bonus was not in use.

When other departments of the plants are considered, it is found that in them also the tendency to rising severity is observable. The only common influence in the several departments which can be detected is the presence of the bonus system. It is therefore possible that the bonus system is actually a contributing factor in the rising severity rate. There are two items about the bonus system which it may be suggested have contributed to this rise in severity rate: (1) Those in charge of the safety departments in these plants, noting the remarkable decline in frequency incident to the introduction of the bonus and knowing that severe cases were not in excess of such cases in similar plants, were not aware that severity was on the increase. No special measures, therefore, were taken to counteract such tendency. (2) Under the bonus system serious injury was not made to count against the foreman in a sufficient degree to induce on his part special attention to the causes of serious injury and the means of prevention.

It may be noted again that without the consideration of severity rates it would be quite impossible to get an accurate picture of the influence of such a device as the foremen's bonus.

"ENGINEERING REVISION" IN BONUS AND NONBONUS PLANTS.

In a later chapter the general question of "engineering revision" as a method of controlling the more severe injuries in industry will be discussed. In the present connection it is interesting to note the experience of bonus and nonbonus plants in those cases in which, in the opinion of the safety committees who pass upon them, prevention was possible by engineering revision. The following table presents the results secured in a bonus and a nonbonus plant, the cases being divided into three groups, namely, "Disability of six weeks and under," "Disability of over six weeks," and "Death and major mutilation."

TABLE 47.—ACCIDENT FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR CASES THAT COULD HAVE BEEN PREVENTED BY ENGINEERING REVISION IN A BONUS AND A NONBONUS PLANT.

Kind of plant.	Disability of 6 weeks or under.	Disability of over 6 weeks.	Death and major mutilation.	Total.
Bonus plant	2.6	0.9	0.5	4.1
Nonbonus plant	.9	.3	.6	1.8

Inspection of the table will show that the bonus plant found engineering remedies possible at the rate of 2.6 cases per million hours' exposure for injuries involving disability of six weeks or under. In the nonbonus plant, on the the other hand, the cases for which similar remedies were discovered were at the rate of 0.9 per million hours' exposure. A comparison of these two rates shows that the foremen of the bonus plant called attention to cases involving disability of six weeks or under and capable of engineering remedy three times as frequently as did those in the nonbonus plants. That is, under a bonus system the foremen show constantly an alert attention to the causes which give rise to minor injury.

In the matter of death and major mutilation, the rate in the bonus plant was 0.5 per million hours' exposure and in the nonbonus plant 0.6. It has already been shown (p. 161) that the bonus plants had on the whole a rising severity rate, while the rate in nonbonus plants was falling. The difference indicated above in the detection of possible engineering revision against severe accidents would be entirely sufficient to account for this opposite movement in severity rates.

It would be too sweeping a conclusion to say that these differences in the application of "engineering revision" are entirely due to the entrance of the bonus system. They may be in some measure the result of inherent differences in the work done in the two plants. However, the fact that attention to small injuries will have considerable influence in protecting the foremen's bonus must not be overlooked as a factor in this situation. Whenever the penalty for serious injury is proportionately too small, it is inevitable that attention will be given to those minor cases whose elimination will easily exceed in importance, from the standpoint of the bonus, the elimination of more serious danger. Suppose, for example, that 10 points are scored against a foreman for a fatal injury. When disability for a single day counts 1 against him, it probably would be easier for the foreman to get rid of the causes of 10 minor injuries than to provide against the recurrence of a fatality. How inadequate such an allowance as 10 for a fatal case is will become evident when attention is called to the fact that in standard procedure in the calculation of severity rates a death is rated as the equivalent of the loss of 6,000 days. It is probably true that such an allowance, while necessary for the determination of satisfactory severity rates, would be excessive in the operation of a foremen's bonus plan. It is clear, however, that heavier penalties for death and major mutilation should be applied if adequate attention to the causes of the more serious injuries is to be secured.

CONCLUSION.

The experience outlined above is much more extensive and has covered a longer period of time than any other which has been subjected to statistical analysis. It is, of course, possible that there are factors in this situation which the painstaking scrutiny given it has failed to disclose. With all possible allowance for such concealed factors the following conclusions seem to be justified: (1) A foremen's bonus for accident reduction will tend very greatly to reduce minor injury and will tend when established to keep down this sort of injury. Such a reduction is of very great importance and would amply justify the application of a bonus system, provided there are no injurious results which offset this value. Both mill efficiency and good feeling among the men are favorably influenced by this diminution of minor injury. (2) A foremen's bonus will not of necessity bring about a satisfactory reduction of the more severe accidents. It did not so operate in this largest and longest continued experiment. It would appear that the influence of the bonus system must be reinforced by the vigorous application of other measures, particularly the engineering study of the situation.

Tables 48 and 49 present, in detail, the data upon which this discussion is based.

TABLE 48.—HOURS OF EXPOSURE AND NUMBER OF ACCIDENTS IN BONUS AND NONBONUS PLANT GROUPS, BY YEARS, 1912 TO 1917.

HOURS (THOUSANDS) OF EXPOSURE.

Plant group.	1912	1913	1914	1915	1916	1917	Total.
Bonus group:							
A—Blast furnaces	2,769	2,895	1,827	1,824	2,589	2,592	14,496
A—Steel works	3,261	3,303	2,313	2,340	3,453	3,702	18,372
A—Rolling mills	5,325	6,582	4,431	4,497	6,468	6,918	34,221
Total	11,355	12,780	8,571	8,661	12,510	13,212	34,221
Nonbonus groups:							
B—Blast furnaces	7,158	7,143	6,291	5,865	8,271	9,546	44,274
B—Steel works	8,772	8,289	5,295	7,740	11,085	12,399	53,580
B—Rolling mills	11,535	14,079	11,145	8,085	11,505	11,526	67,875
Total	27,465	29,511	22,731	21,690	30,861	33,471	165,729
C—Blast furnaces	2,388	2,361	2,640	2,832	3,510	3,594	17,325
C—Steel works	3,006	3,030	2,202	2,670	3,237	3,582	17,727
C—Rolling mills	2,601	2,619	2,043	2,487	2,931	3,183	15,864
Total	7,995	8,010	6,885	7,989	9,678	10,359	50,916
D—Blast furnaces	13,923	11,925	12,654	10,410	10,104	10,707	69,723
D—Steel works	5,193	5,268	3,429	3,918	4,284	4,374	26,466
D—Rolling mills	10,839	12,225	9,990	12,384	9,522	12,261	67,221
Total	29,955	29,418	26,073	26,712	23,910	27,342	163,410
Total, nonbonus (B, C, and D)	65,415	66,939	55,689	56,391	64,449	71,172	380,055
Grand total	76,770	79,719	64,260	65,052	76,959	84,384	447,144

TABLE 48.—HOURS OF EXPOSURE AND NUMBER OF ACCIDENTS IN BONUS AND NONBONUS PLANT GROUPS, BY YEARS, 1912 TO 1917—Concluded.

NUMBER OF ACCIDENTS.

Plant group.	1912	1913	1914	1915	1916	1917	Total.
Bonus group:							
A—Blast furnaces	196	116	19	29	41	28	429
A—Steel works	246	131	35	37	55	54	558
A—Rolling mills	238	190	51	62	87	77	705
Total	680	437	105	128	183	159	1,692
Nonbonus groups:							
B—Blast furnaces	335	269	170	135	226	208	1,343
B—Steel works	633	622	255	248	378	309	2,445
B—Rolling mills	630	600	268	193	292	197	2,180
Total	1,598	1,491	693	576	896	714	5,968
C—Blast furnaces	269	189	187	167	218	162	1,192
C—Steel works	254	220	114	175	247	150	1,160
C—Rolling mills	166	140	84	138	156	126	810
Total	689	549	385	480	621	438	3,162
D—Blast furnaces	781	952	506	234	417	346	3,236
D—Steel works	421	369	151	231	476	401	2,049
D—Rolling mills	568	501	265	323	382	245	2,284
Total	1,770	1,822	922	788	1,275	992	7,569
Total, nonbonus (B, C, and D)	4,057	3,862	2,000	1,844	2,792	2,144	16,699
Grand total	4,737	4,299	2,105	1,972	2,975	2,303	18,391

TABLE 49.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR BONUS AND NONBONUS PLANT GROUPS IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, BY YEARS, 1912 TO 1917.

BLAST FURNACES.

Plant group.	Frequency rates (per 1,000,000 hours' exposure).							Severity rates (per 1,000 hours' exposure).						
	1912	1913	1914	1915	1916	1917	Total	1912	1913	1914	1915	1916	1917	Total
A (bonus)	70.8	40.1	10.4	15.9	15.8	10.8	.....	4.6	4.1	1.9	5.3	4.3	7.5	.....
B (nonbonus)	46.8	37.7	27.0	23.0	27.3	21.8	.....	3.8	6.2	4.8	12.9	2.7	7.8	.....
C (nonbonus)	112.6	80.1	70.8	59.0	62.1	45.1	.....	31.9	10.8	6.5	4.7	9.4	8.8	.....
D (nonbonus)	56.1	78.2	40.0	22.5	41.3	32.3	.....	2.7	6.0	4.9	1.0	3.2	2.9	.....
Total	60.3	62.7	37.7	27.0	36.9	28.1	.....	5.9	6.7	4.8	5.2	4.1	5.9	.....

STEEL WORKS.

Plant group.	1912	1913	1914	1915	1916	1917	Total	1912	1913	1914	1915	1916	1917	Total
A (bonus)	75.4	39.7	15.1	15.8	15.9	14.6	.....	3.7	1.0	3.1	1.3	3.4	4.1	.....
B (nonbonus)	72.2	75.0	48.2	32.0	34.1	24.9	.....	7.3	8.4	8.4	3.4	5.0	2.7	.....
C (nonbonus)	84.5	72.6	51.8	65.5	76.3	41.9	.....	8.6	2.8	7.2	10.4	7.3	8.4	.....
D (nonbonus)	81.1	70.0	44.0	59.0	111.1	91.7	.....	4.2	5.8	1.3	2.4	13.3	5.9	.....
Total	76.8	67.5	41.9	41.5	52.4	38.0	.....	6.1	5.6	5.4	4.0	6.7	4.4	.....

HEAVY ROLLING MILLS.

Plant group.	1912	1913	1914	1915	1916	1917	Total	1912	1913	1914	1915	1916	1917	Total
A (bonus)	44.7	28.9	11.5	13.8	13.5	11.1	.....	1.2	0.9	2.2	1.9	2.4	0.6	.....
B (nonbonus)	54.6	42.6	24.0	23.9	25.4	17.1	.....	3.9	3.5	3.3	5.9	2.7	2.4	.....
C (nonbonus)	63.8	53.5	41.1	55.5	53.2	39.4	.....	6.1	2.8	1.0	7.6	5.5	10.8	.....
D (nonbonus)	52.4	41.0	26.5	26.1	40.1	20.0	.....	4.2	1.2	1.7	.8	3.7	.8	.....
Total	52.9	40.3	24.2	26.1	30.1	19.0	.....	3.7	2.2	2.4	3.1	3.2	2.2	.....

TABLE 49.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR BONUS AND NON-BONUS PLANT GROUPS IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, BY YEARS, 1912 TO 1917—Concluded.

ALL PLANTS.

Plant group.	Frequency rates (per 1,000,000 hours' exposure).							Severity rates (per 1,000 hours' exposure).						
	1912	1913	1914	1915	1916	1917	Total	1912	1913	1914	1915	1916	1917	Total
A (bonus)	59.9	34.2	12.3	15.0	12.0	12.0	25.2	2.7	1.6	2.4	2.5	3.1	2.9	2.5
B (nonbonus)	58.2	50.5	30.5	26.6	29.0	21.0	36.0	15.0	5.5	4.9	6.9	3.5	4.0	4.9
C (nonbonus)	86.2	68.5	55.9	60.1	64.2	42.3	62.1	14.7	5.2	5.1	7.5	7.5	9.3	8.3
D (nonbonus)	59.1	61.9	35.4	29.5	53.3	36.3	46.3	3.3	4.3	3.2	1.1	5.2	2.4	3.3
Total, nonbonus (B, C, and D)	62.0	57.7	35.9	32.7	43.3	30.1	43.9	5.5	5.0	4.1	4.2	4.8	4.2	4.6
Total (A, B, C, and D)	61.7	53.9	32.8	30.3	35.3	27.3	41.1	5.1	4.4	3.9	4.0	4.5	4.0	4.3

THE WORKERS.

The worker, just because he is an ordinary human being, is subject to certain influences which may seriously increase the likehood of his being injured. The most conspicuous of these influences is that of inexperience. The youthful worker or the one who recently entered upon a given pursuit lacks the practice which gives control and skill and so has a higher accident rate than the more experienced.

Unfavorable bodily conditions, such as attend exposure to extremes of heat and cold, or night work, or illness, or fatigue may be reflected in higher accident rates.

It will appear later that these unfavorable personal conditions effect more promptly and more often the occurrence of minor injury than cases of severer injury, in which there is likely to be some defect of structure or arrangement without which the injury would not have occurred and the man is therefore no more than a contributing cause of the result.

INFLUENCE OF INEXPERIENCE UPON ACCIDENTS.

The fact that the inexperienced man is especially subject to accident may be demonstrated from a number of sources. Table 50, showing accident rates according to length of service, is of particular interest upon this point.

TABLE 50.—ACCIDENT FREQUENCY RATES ACCORDING TO PERIOD OF WORKERS' EMPLOYMENT IN A LARGE STEEL PLANT.

[Based on data for January-May, 1916.]

Length of service.	Equivalent full-year workers.	Cases of accident.	Accident frequency rates (per 1,000,000 hours' exposure).
6 months and under	512	57	37.1
Over 6 months and not over 1 year	278	29	34.8
Over 1 year and not over 3 years	357	31	28.9
Over 3 years and not over 5 years	637	27	14.1
Over 5 years and not over 10 years	814	16	6.6
Over 10 years and not over 15 years	470	4	2.8
Over 15 years	459	....	....
Total	3,527	164	15.5

The table indicates clearly an extremely rapid decline in accident frequency with increased experience on the part of the worker. For those who had been employed 6 months or less the frequency rate was 37.1 cases per 1,000,000 hours' exposure. This dropped to 34.8 cases for those with 6 months' to 1 year's experience. Thereafter the rate declined very rapidly, and among those who had been employed more than 15 years no accidents occurred during the period covered.

These figures are so striking that, notwithstanding the comparatively small number of workers concerned, they would seem to be conclusive as to the close relationship between inexperience and high accident rates. This conclusion, moreover, is supported by other tabulations presented later, based on the age of the worker and the degree of his ability to speak English.

That the "green" man is particularly subject to accident has been recognized to some extent and in a number of plants special efforts have been made to train and to caution him. But the full effect of this factor has not been perceived. Careful analysis indicates that inexperience plays a very important part in accident occurrence and suggests that it may be an extremely influential factor in the increase in accident rates which, almost invariably, accompanies an increase in business activity.

That accident rates do increase in periods of business activity is evidenced by numerous tabulations in this report. Thus the recovery from the industrial depression of 1908 was accompanied in practically all plants covered by this study by a marked rise in accident rates. This experience occurred so regularly that there is clearly some close connection between increased activity and increasing accident rates. What is this connection? Why should increasing plant activity mean higher accident rates? Two possible reasons suggest themselves. The first is that the rising accident rates may be due to "speeding up"—i. e., to the greater intensity and stress of the work placed upon the individual workman. The evidence of laboratory test and mill experience is to the effect that sudden increments of speed are accompanied by greater accident frequency. That such speeding up may have occurred during periods of business activity in the steel plants covered is suggested by the fact that at such periods the output per worker employed shows an increase. But increased per capita output does not absolutely prove increased individual exertion, as the output increase might be due to modifications of equipment and methods which would tend to lessen rather than to increase the individual's effort. But even granting that speeding up does occur in a period of plant activity, and it is probable that it does occur in some degree, it is still questionable whether it is sufficient to account for the sharply rising accident rates.

The second reason which suggests itself as possibly a cause of the rising accident rates in times of increasing business activity is the influence of the new men added to the working force. At such a time the working force is necessarily increased. Among those recruited there is necessarily a more or less considerable element of inexperienced men. Because of their inexperience these men are, as has been noted above, especially subject to accident, and their presence in the plant would tend in itself to swell the accident frequency rate. This factor could easily be one of very great importance. Indeed, careful analysis of several plants leads to the belief that it is this factor of inexperience, introduced into a plant at a time of heavy labor recruiting, which is primarily responsible for the rising accident rates following a period of depression.

The effect of introducing inexperienced men into the working force is forcibly indicated by Chart 10. It represents the trend in a large steel plant of four correlated elements over a period of 11 years, which include three periods of high industrial stress—1910, 1913, and the war period.

The chart includes (1) a curve of employment showing the increases and decreases over the period; (2) a curve showing the rates at which new men were entering the force; (3) accident rates; (4) the product per man.

To bring these items into such relations with each other that they can be conveniently entered upon one chart they were reduced to index numbers based on the year 1908 as 100. They were then plotted on a percentage scale. For the sake of economizing space only the years ending with alternate months are used. It was found by experiment that no essential point in the relation of the curves was obscured by this process.

It may be noted first that all the items rise and fall with changing industrial conditions. The "new man accession rate" is the most widely variable. This rate represents, of course, the proportion of inexperience which is to be found in the working force at various times. The production rate, being the product per man, is a measure of individual activity in some degree, but may also reflect modifications in equipment and method.

If the course of the "new man accession rate" be compared with that of accidents a close and interesting parallelism will be observed. In the earliest active period the two rates reach a climax at about the same time, in 1910 at precisely the same month. In the war period the "new man accession rate" was continuously high for a number of years and accidents maintained a closely corresponding high position.

The production rate in the earlier active periods reached its peak at a later time than either accessions or accidents. That is, whatever effect "speeding up" may have had on the accident rate it was not sufficient to hold up that rate when the accession rate began to fall. This situation during the war period was necessarily much complicated by conditions which it is impossible to determine exactly. It is evident, however, that here, as in the earlier periods, the controlling factor in the rise of the accident rate is the accession of new men.

It might be inferred, from the fact that in two cases product per man was rising with a falling accident rate, that speed of production in such mills as these has no relation to the frequency of accident. This conclusion is not justified, because it is possible that without the influence of increasing speed the accident rate would have fallen more rapidly than it did.

These illustrations, drawn from the iron and steel industry, emphasize two points: (1) The inexperienced man has a high accident rate, and (2) when he is introduced into a working force in considerable

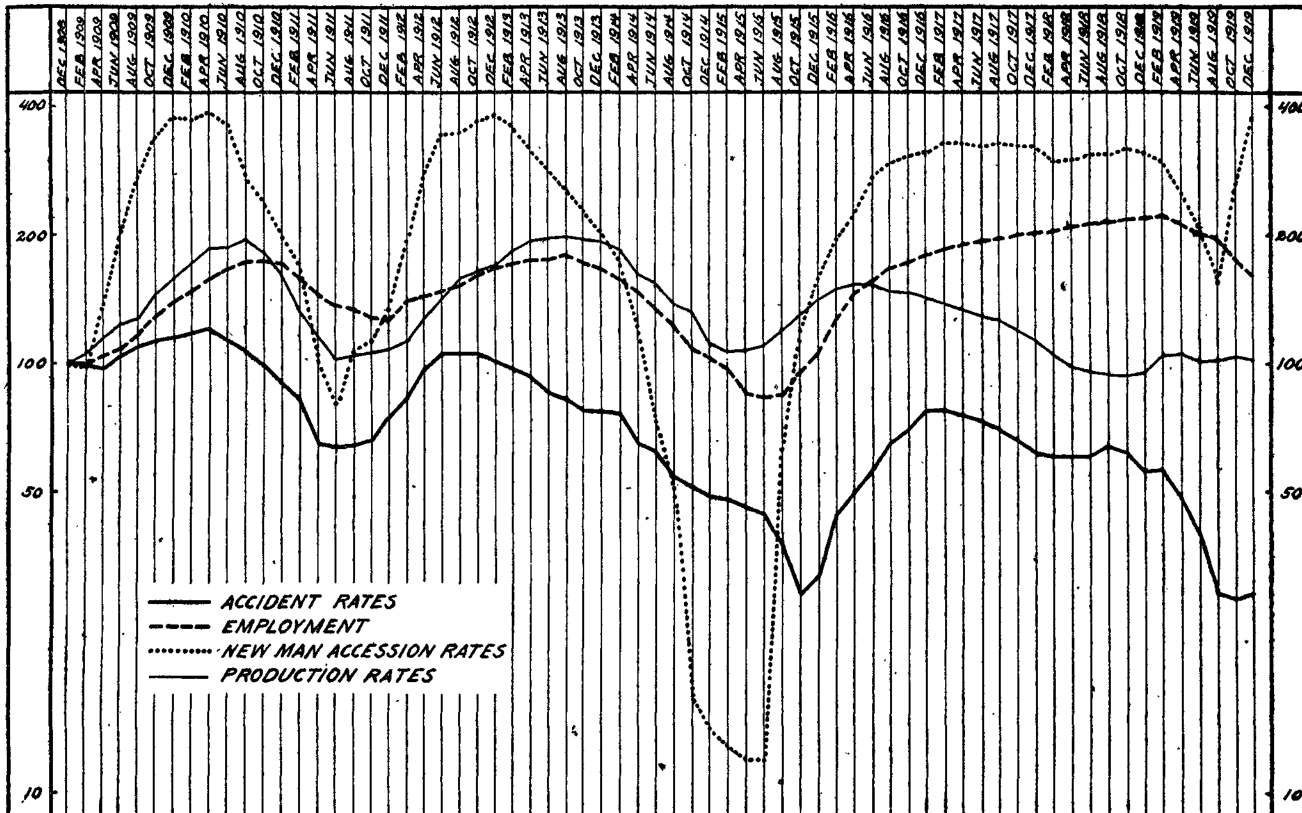


CHART 10.—RELATION OF EMPLOYMENT, ACCESSION OF NEW MEN, AND PRODUCTION TO ACCIDENT OCCURRENCE IN A LARGE STEEL PLANT, 1908 TO 1914.

numbers it may be expected that, unless extraordinary efforts are made to train him and to introduce him to his work, the accident rate will rise.

The accident rates of the chart bring out another point very clearly. In each of the latter periods, although accessions reached a rate of increase equal to that in the first period, accidents did not reach so high a point. This is clearly due to the progressive influence of safety effort as applied in these mills.

Some further illustrations from other fields will be pertinent.

EXTREME INEXPERIENCE.

In an earlier study [57] of press hands in the metal trades the following table was compiled which shows in a very striking manner the hazard of the extremely inexperienced.

TABLE 51.—AVERAGE NUMBER OF PRESS HANDS AND OF EMPLOYEES IN OTHER OCCUPATIONS IN THE METAL TRADES INJURED PER DAY AFTER BEGINNING WORK ON MACHINE, BY SEX.

Occupation.	Average number injured per day.				
	1st day.	2d day to end of 1st week.	2d week to end of 1st month.	2d month to end of 6th month.	7th month to end of 1st year.
Press hands:					
Males	77	13	3	0.78	0.21
Females	252	33	4	.71	.26
Total	329	46	7	1.49	.47
Other occupations:					
Males	89	25	8	3.00	1.00
Females	42	12	2	.69	.32
Total	131	37	10	3.69	1.32
All occupations:					
Males	166	38	11	3.00	1.00
Females	294	45	6	1.00	.57
Total	460	83	17	4.00	1.57

This table shows a very great excess of accident occurrence on the first day on the machine. If this could be placed on a rate basis, it would be still more striking.

In connection with the study from which Table 51 is taken 435 cases of accident to press hands during the first day of employment on the press and 537 cases of metal workers injured after a year

[57] Report on Condition of Woman and Child Wage Earners, Vol. XI, Employment of Women in the Metal Trades, S. Doc. No. 645, 61st Cong., 2d sess.

or more of experience were recorded for which the hour of injury was known. A tabulation of these cases follows:

TABLE 52.—ACCIDENTS TO INEXPERIENCED PRESS HANDS AND TO EXPERIENCED METAL WORKERS, BY HOUR OF THE DAY.

Hour ending at—	Accidents in each hour.			
	Number.		Per cent.	
	Press hands—1st day of employment.	Metal workers—after 1 year or more of employment.	Press hands—1st day of employment.	Metal workers—after 1 year or more of employment.
8 a. m.	38	42	8.74	7.82
9 a. m.	50	65	11.49	12.10
10 a. m.	*66*	67	*15.17*	12.48
11 a. m.	58	*78*	13.33	*14.52*
12 m.	41	40	9.42	7.44
Total, forenoon	253	292	58.15	54.36
2 p. m.	46	46	10.57	8.57
3 p. m.	*52*	65	*11.95*	12.10
4 p. m.	44	*66*	10.11	*12.29*
5 p. m.	30	50	6.90	9.31
6 p. m.	10	18	2.30	3.35
Total, afternoon	182	245	41.85	45.64
Grand total	435	537	100.00	100.00

The table showing the distribution of accidents through the hours of the day indicates that not only does the beginner have a high accident rate, as shown by Table 51, but also that he is much influenced by that lack of coordination which more or less besets any worker in resuming a task in the morning. When the beginner's accident rate is compared with that of the more experienced worker, it is found that his rate is higher and his efforts for speed produce a more rapidly rising rate during the morning hours.

It may be said in conclusion that the fluctuations in accident rates which accompany industrial revival and depression are really one phase of the larger problem of "labor turnover." Any methods which may be devised to lessen the one will favorably affect the other.

SELECTIVE DISCHARGE.

The lessened accident rates of periods of depression have been attributed above to the decrease in the introduction of new men, together, perhaps, with lessened industrial tension. There is another factor operative to which it is desirable to call attention. It may be called "selective discharge." Whenever depression sets in all the men are naturally desirous of retaining their jobs. The employer therefore exercises selection in deciding whom he will let go. The skillful and mature man will naturally be retained, while the younger, less skillful, and less experienced man will be laid off. The effect of this process is to raise the average quality of the working force and thus to influence favorably the accident rate.

GEOGRAPHIC LOCATION AS A POSSIBLE FACTOR.[58]

Comparison of the accident rates of different plants reveals the fact that some in which safety work of the highest quality is being

[58] For racial distribution of steel workers see Report on Conditions of Employment in the Iron and Steel Industry in the United States (S. Doc. No. 110, 62d Cong., 1st sess.), Vol. III, p. 83 et seq.

done have constantly higher rates than others in which the safety work is apparently of a lower quality. A probable explanation of this is that the high rates of the former plants may be influenced by the fact that they are so located geographically as to constitute ports of entry, as it were, for new immigrant labor. Their records indicated a higher proportion of men entirely without experience in the industry, although in some cases their labor turnover was less than in other plants which had attained to lower accident rates.

If this indication should prove upon closer scrutiny to be constant, it would afford an explanation of the striking contradiction noted above. At present such an explanation can not be established conclusively, but it may be suggested as possible, in justice to some very efficient safety men who may be doing their work under an extra handicap.

INFLUENCE OF AGE UPON ACCIDENTS.

It is very difficult to determine the influence of the worker's age upon accident occurrence because of the fact that the work done by persons of different age groups may not be uniform. If the work done is not uniform, a higher accident rate for those of one age group may be due not at all to the factor of age but simply to the higher hazards of their particular tasks. The information available upon this subject is not conclusive, but an analysis of such as could be obtained brings out some points of interest.

An important body of data regarding age as related to accident frequency was presented in the earlier report of the bureau upon accidents in the iron and steel industry.[59] The table is reproduced, in substance, below. It shows the accident frequency rates over a period of five years for a total of 33,511 full-year workers employed in a large steel plant. In this case it was not possible to compute severity rates.

TABLE 53.—FREQUENCY OF ACCIDENTS IN A LARGE STEEL PLANT ACCORDING TO AGE GROUPS, 1906 TO 1910, BY YEARS.

Age group.	1906	1907	1908	1909	1910	Total (5 years).
Number of workers:						
Under 20 years	475	384	198	261	390	1,708
20 to 29 years	3,875	3,810	2,214	3,343	3,264	16,506
30 to 39 years	2,047	2,256	1,242	1,697	2,271	9,513
40 years and over	1,097	1,135	921	914	1,717	5,784
Total	7,494	7,585	4,575	6,215	7,642	33,511
Number of accident cases of workers—						
Under 20 years	52	56	8	30	27	173
20 to 29 years	760	694	364	577	527	2,922
30 to 39 years	382	374	183	304	298	1,541
40 years and over	156	170	89	143	115	673
Total	1,350	1,294	644	1,054	967	5,309
Accident frequency rates (per 1,000,000 hours' exposure) for workers—						
Under 20 years	36.5	48.6	13.5	38.3	23.1	33.8
20 to 29 years	65.4	60.7	54.8	57.5	53.8	59.0
30 to 39 years	62.0	55.3	49.1	59.7	43.7	54.0
40 years and over	47.4	49.9	32.2	52.2	23.3	38.8
Total	60.4	56.9	46.9	56.5	42.2	52.8

[59] Report on Conditions of Employment in the Iron and Steel Industry in the United States (S. Doc. No. 110, 62d Cong., 1st sess.), Vol. IV, p. 159.

The first point to be noted in the table is that the decline in accident frequency rates which took place between the beginning and end of the period covered occurred in each of the age groups as well as in the total.

The second point to be noted is that for the combined five-year period, and also for each of the individual years, except 1909, the age group 20 to 29 showed the highest accident frequency. Next highest to the 20 to 29 age group in accident frequency is the 30 to 39 group, with the 40 and over group next in order and the under 20 group lowest of the four. In order to understand the significance of this order it is necessary to consider the occupational status of each of the age groups. The group under 20 is that engaged in the least hazardous work. Most of those who belong to it are door boys and lever operators. Those of 40 and over have to a certain degree passed out of the danger zone. Many of those who have passed but little over the boundary line are still to be found in the dangerous occupations, and probably on this account the accident rate is higher than that for those under 20. But the differences which exist in the work of these two groups are so considerable that it is impossible to judge whether the factor of age is at all a significant one. If the groups could be placed under nearly identical occupational conditions, the rates might be changed, or even reversed.

The two age groups, 20 to 29 and 30 to 39, include by far the larger proportion of the steel workers. From statistics showing the age distribution in the various departments[60] and from careful observation the dangers to men in the older age group appear to be as great as those encountered by the younger. In fact inquiry shows that those who are particularly exposed to the special hazards, such as arise in the moving of molten metal, have very commonly reached their present position by a prolonged apprenticeship and are very apt to be men above 30. It is a reasonable conclusion, therefore, that danger in the younger age group is not greater than in the older. It appears that the 20 to 29 age group has the higher rate in each year except one, and that for the whole period the rate is decidedly higher for this group.

It becomes, then, appropriate to inquire the reason for this higher rate, since apparently it can not be attributed to more dangerous occupations. The probable causes may be summed up as inexperience and immaturity. This age group, 20 to 29, furnishes the greatest number of recruits for the steel industry. Those of the group 30 to 39 are relatively experienced men who entered the works earlier or, in rare instances where they are recently arrived immigrants, they have a degree of maturity which is not true of those between 20 and 29. The great factor is undoubtedly that of inexperience. Many of these young men come directly from an agricultural life and are exposed upon their entrance into the activities of the steel mill to all the dangers which inevitably beset beginners.

The experience of a second large steel plant, as regards the relation of age and accident, is given in Table 54. In this, as in the plant just discussed, the accident reduction which had taken place over a period of years had affected all age groups. But as it does not seem necessary further to establish this point, the data for the

---

[60] Report on Conditions of Employment in the Iron and Steel Industry in the United States (S. Doc. No. 110, 62d Cong., 1st sess.), Vol. III, p. 99.

several years are combined in order to get as large an exposure as possible. Accident severity rates, as well as frequency rates, are given in detail.

TABLE 54.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR A LARGE STEEL PLANT, 1907 TO 1914, BY AGE GROUPS.

Age group.	Number of workers.	Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Under 20 years	949	0.31	2.47	184.8	187.58	2.10	1.47	2.57	6.14
20 to 29 years	16,443	.23	1.13	76.7	78.06	1.33	.77	1.17	3.27
30 to 39 years	14,417	.23	.80	58.5	59.53	1.37	.40	.97	2.74
40 years and over	11,124	.17	.93	42.8	43.90	1.10	.50	.87	2.47
Total	42,933	.23	1.00	64.2	65.43	1.30	.60	1.03	2.93

The accident rates of this table conform very closely to those of the preceding table with the exception of the rates for the age group under 20. For this group the accident rates are here extremely high, in sharp contrast with the experience shown in Table 53. This is due, in part, to the practice of this plant of employing young men along with older men in occupations likely to produce many cases of short-term disability. But at best the group is too small (949 full-year workers) to permit of conclusive deductions. Its smallness of size would be reflected especially in the severity rate, since, in small groups, a single fatality influences the severity rate materially. More significant is the fact that this group has the highest severity rate for both permanent and temporary disability. Clearly, when such youths do engage in the same work as more experienced workers, their hazards are very serious.

It is very possible that the workers under 20, being a small group among a much larger group of older workers, and furnishing only a limited number of accidents, have never had their high accident rates observed. The condition disclosed by this tabulation, therefore, suggests the desirability of every plant's making, from time to time, a critical examination of the working force by age groups.

Table 55 presents the accident experience of a tube mill by age groups. The age group under 20 is omitted, as the number of persons therein was too small to justify the computation of rates.

TABLE 55.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR A TUBE MILL, 1907 TO 1914, BY AGE GROUPS.

Age group.	Number of workers.	Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
20 to 29 years	6,351	0.10	1.03	69.1	70.23	0.63	0.70	1.03	2.36
30 to 39 years	4,977	.07	.73	50.2	51.00	.40	.40	.80	1.60
40 years and over	2,965	.33	.57	34.0	34.90	2.03	.37	.63	3.03
Total	14,293	.13	.83	55.2	56.16	.83	.53	.87	2.23

The relations of these age groups in regard to accident frequency, it will be noted, are the same as in the two preceding tables. In the matter of severity, however, age group 40 and over has the leading place, due entirely to the high death rate.

ACCIDENTS AMONG NON-ENGLISH-SPEAKING WORKERS.

Of all inexperienced workers the man most handicapped would seem to be the one who not only is without knowledge of his task, but also is unable to communicate freely with those who direct him. When one large company began to study carefully their working conditions they found it not infrequently the case that a foreman was in charge of a gang with no member of which could he communicate either directly or by an interpreter. Still more common was it to find individual men who were thus barred from communication with their immediate superior. This was at once recognized as a dangerous condition and the rule was issued that gangs should be formed in such a manner that each man should be able to communicate with his foreman directly or by interpreter.

The following table contrasts accident rates of (1) American-born workers, (2) English-speaking foreign-born workers, and (3) non-English-speaking foreign-born workers, over a period of 8 years, 1906 to 1913, in the only plant for which full data could be obtained:

TABLE 56.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR AMERICAN-BORN AND ENGLISH AND NON-ENGLISH SPEAKING FOREIGN-BORN GROUPS IN A LARGE STEEL MILL, 1906 TO 1913, BY YEARS.

Group.	Number of workers.	Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1906.									
American born	1,370	1.9	1.9	47.7	51.5	11.7	2.2	0.7	14.6
English-speaking foreign born	1,906	2.3	1.9	36.6	40.8	14.0	1.0	.6	15.6
Non-English-speaking foreign born	4,218	1.4	1.9	81.0	84.3	8.2	1.3	1.2	10.7
Total	7,494	1.7	1.9	61.7	65.3	10.4	1.8	1.0	13.2
1907.									
American born	1,719	1.2	.8	33.3	35.3	7.0	1.1	.7	8.8
English-speaking foreign born	2,267	1.0	1.3	51.9	54.2	6.2	3.0	.9	10.1
Non-English-speaking foreign born	3,599	1.1	2.5	64.8	68.4	6.7	2.3	1.4	10.4
Total	7,858	1.1	1.7	54.3	57.1	6.4	2.6	1.1	10.1
1908.									
American born	1,188	.3	1.7	25.8	27.8	1.7	1.0	.5	3.2
English-speaking foreign born	1,689	1.0	1.6	31.4	30.4	5.9	1.1	.6	7.6
Non-English-speaking foreign born	1,698	1.2	2.4	60.9	64.5	7.1	2.7	1.2	11.0
Total	4,575	.9	1.9	40.9	43.7	5.2	1.7	.8	7.7
1909.									
American born	1,453	.5	.2	31.9	32.6	2.8	.4	.5	3.7
English-speaking foreign born	2,027	1.2	1.3	41.1	43.6	6.9	.8	1.0	8.7
Non-English-speaking foreign born	2,735	.5	.9	66.7	68.1	2.9	1.4	1.1	5.4
Total	6,215	.7	.9	50.2	51.8	4.2	.9	.9	6.0

TABLE 56.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR AMERICAN-BORN AND ENGLISH AND NON-ENGLISH SPEAKING FOREIGN-BORN GROUPS IN A LARGE STEEL MILL, 1906 TO 1913, BY YEARS—Concluded.

Group.	Number of workers.	Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1910.									
American born	1,843	0.4	0.2	22.4	23.0	3.3	0.2	0.3	3.8
English-speaking foreign born	3,283	.2	.6	16.3	17.1	1.8	.5	.2	2.5
Non-English-speaking foreign born	2,516	1.1	3.0	74.9	79.0	9.5	1.4	1.4	12.3
Total	7,642	.5	1.3	37.0	38.8	4.7	1.1	.6	6.4
1911.									
American born	1,369	1.0	1.0	25.8	27.8	8.8	.4	.4	9.6
English-speaking foreign born	2,446	.5	1.1	28.3	29.9	4.9	1.2	.8	6.9
Non-English-speaking foreign born	1,959	.2	1.5	54.3	56.0	1.5	1.4	1.1	4.0
Total	5,774	.5	1.2	36.5	38.2	4.7	.8	.7	6.2
1912.									
American born	1,863	....	1.1	28.8	29.9	....	.6	.5	1.1
English-speaking foreign born	2,656	.1	2.4	29.7	32.2	1.1	2.0	.6	3.7
Non-English-speaking foreign born	2,887	.5	2.7	82.2	85.4	4.2	2.4	1.5	8.1
Total	7,406	.2	2.2	49.9	52.3	2.0	1.8	.9	4.7
1913.									
American born	1,782	.6	.9	18.9	20.4	5.1	.2	.3	5.6
English-speaking foreign born	2,472	.7	.7	27.0	28.4	6.1	.6	.5	7.2
Non-English-speaking foreign born	2,877	.5	2.7	83.2	86.4	4.2	2.4	1.5	8.1
Total	7,562	.6	1.5	37.9	40.0	5.6	.7	.8	7.1
1906–1913.									
American born	12,587	.7	.9	28.6	30.2	4.1	.7	.5	5.3
English-speaking foreign born	18,746	.8	1.3	30.8	32.9	4.7	1.4	.7	6.8
Non-English-speaking foreign born	22,910	.9	2.2	67.8	70.9	5.1	1.5	.9	7.5
Total	54,243	.8	1.6	45.9	48.3	4.7	1.4	.8	6.9

It is very noteworthy that, in all the years covered by this table, the non-English speakers not only had the highest frequency rates but show little if any improvement from year to year. In severity the non-English speakers show the highest rates in five out of the eight years covered and show much less improvement than do the English speakers.

An examination of the combined data for the eight years will disclose that the non-English speakers have a frequency rate 2.3 times that of the American born (70.9 against 30.2 cases per 1,000,000 hours' exposure) and a severity rate 1.4 times as great (7.5 against 5.3 days per 1,000 hours' exposure).

Table 57 shows the composition of the working force from 1915 to 1919.

TABLE 57.—NUMBER OF AMERICAN BORN AND ENGLISH AND NON-ENGLISH-SPEAKING FOREIGN-BORN WORKERS IN A LARGE STEEL MILL, 1915 TO 1919, BY YEARS.

Group.	1915	1916	1917	1918	1919
American born	1,401	2,223	3,679	3,702	4,185
English-speaking foreign born	1,877	2,710	4,275	3,986	3,730
Non-English-speaking foreign born	2,012	3,326	2,774	2,777	1,162
	5,290	8,259	10,728	10,465	9,077

It proved to be impossible to determine with reasonable accuracy the ability to speak English of those injured during the 5-year interval. The table shows an interesting modification in the proportion of American born and English speakers in recent years. This is due largely to the shutting off of immigration during the war and the introduction of colored laborers. The effect of this change on accident rates can not be determined at this time.

DAY AND NIGHT ACCIDENT RATES.

The impression that the night turn is less dangerous than the day turn has been quite prevalent among safety men. This impression has been the result apparently of limiting attention to the comparative number of accidents rather than to comparative accident rates. The number of accidents on the night turn is almost invariably much the smaller, because very much fewer men are employed by night than by day.

In the iron and steel industry there is a definite tendency toward higher accident rates at night. The following statement summarizes all the material upon this subject obtained in the course of the present investigation, together with such data as are available from other sources:

Higher rates at night have been found to exist in the following cases:

United States. Steel plant with average employment of	8,000
United States. Steel plant with average employment of	5,000
United States. Machine building plant with average employment of	15,000
United States. Plant producing electrical apparatus, with average employment of	17,000
Germany. Iron and steel industries in Dusseldorf district, with average employment of	61,719
Germany. Machine building in Dusseldorf district, with average employment of	3,546

Higher rates by day have been found to exist in the following cases:

United States. Steel plant with average employment of	6,000
Germany. Miscellaneous industries in Dusseldorf district, with average employment of	24,022

There are several factors bearing on the subject of night accident hazards, some operating in one direction, some in the other. They may be stated as follows:

(*a*) Tending to lower the rates at night—
- (1) Smaller proportion of relatively inexperienced and unskilled men.
- (2) Less congestion.
- (3) Less transportation of material.
- (4) Tendency not to undertake difficult repairs.

(b) Tending to raise the rates at night—
- (1) Imperfect lighting.
- (2) Unsatisfactory physical and mental condition of the worker.
- (3) Less rigorous supervision.

Apparently up to the present time the forces tending to higher rates have had the greater influence. As illustrations are offered it will become evident that in the progress of time the disparity between night and day rates has become less and that in some cases a condition of lower rates at night has been reached.

Of the factors tending to high night rates imperfect lighting has naturally received the larger share of attention. This is a matter of efficient operation, and illuminating engineers are showing very conclusively that adequate provision in this respect will immediately return more than its cost in greater output.

Undoubtedly the most difficult problem is that of the worker's condition at night. This is related in no small measure to the difficulty of securing adequate recuperation by proper sleep. The experience of British munition factories shows that continuous night work seriously impairs the efficiency of the workers.[61] The light and noise of daytime and the heat of summer conspire to render sleep in day hours unrefreshing. This discomfort may easily lead to efforts for relief in themselves injurious.

EXAMPLES OF NIGHT AND DAY RATES.

The experience of a large steel plant is shown in the following charts. These give separately, for the day turn and the night turn, the frequency and severity rates over a period of years and by departments.

In the years studied in this plant the frequency rates for night were in excess in each year and the rates for severity in excess in each year but one. The night rates decrease more rapidly than those for the day. This gradual approximation is more regular in the severity rates than in those for frequency. Improved lighting has been suggested as a cause. This must have had great influence but can hardly be the complete explanation. The improvements in lighting were made at particular periods with intervals of uniformity between. If lighting were the controlling factor it would naturally be expected that some rather pronounced change would appear at the time of lighting improvement. Since the decline in rates is fairly constant some constant cause may be suspected. The use of alcohol as a possible influence is discussed later in this chapter.

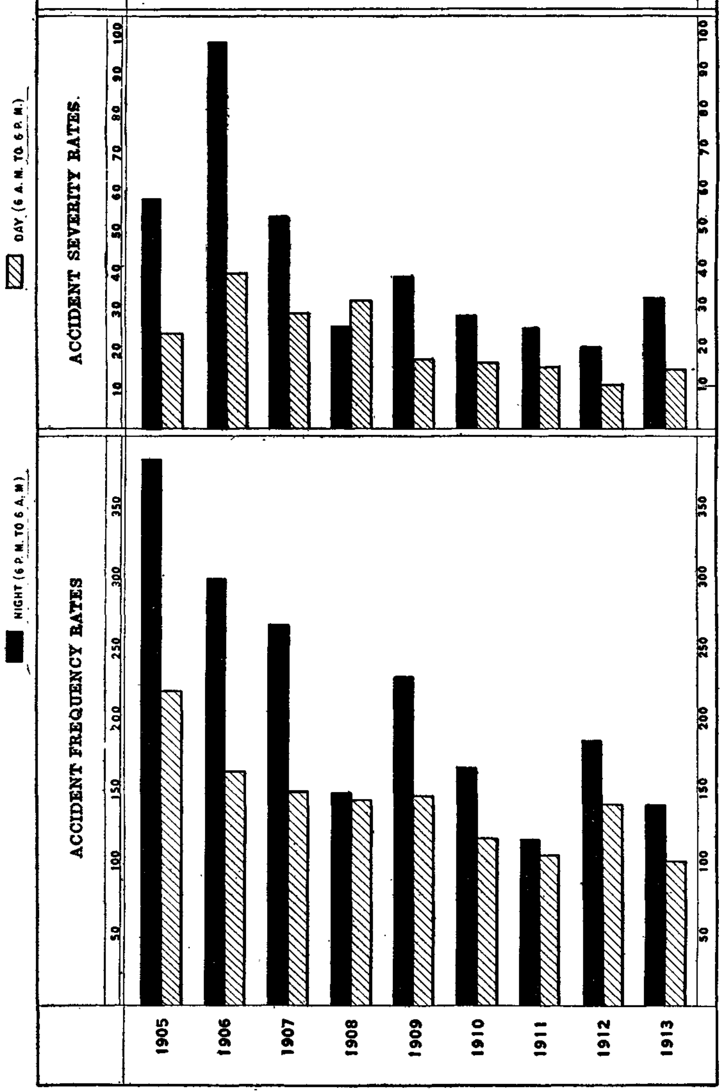
When the experience of this plant is considered from a departmental standpoint some interesting deductions are possible. The mechanical and yard departments call for particular notice in this respect. The high frequency rates at night among mechanics is doubtless the result of two factors: (1) The night force is almost entirely engaged in what is called field work. Shop work on lathe and planer is not undertaken as a rule at night, except in cases of extreme urgency. The force is kept on duty mainly for imperative repairs needed to keep the mills running, and consequently demand-

[61] Health of Munition Workers Committee (Ministry of Munitions). Interim report on Industrial Efficiency and Fatigue (1917), p. 26 et seq.

ing all possible speed. (2) The lighting factor. Often the repairs must be made in places which do not call for careful lighting on

CHART 11.—NIGHT AND DAY ACCIDENT RATES IN A LARGE STEEL PLANT, BY YEARS.

[Frequency rate here means number of accidents per 1,000 300-day workers; severity rate here means number of days lost per 300-day worker.]

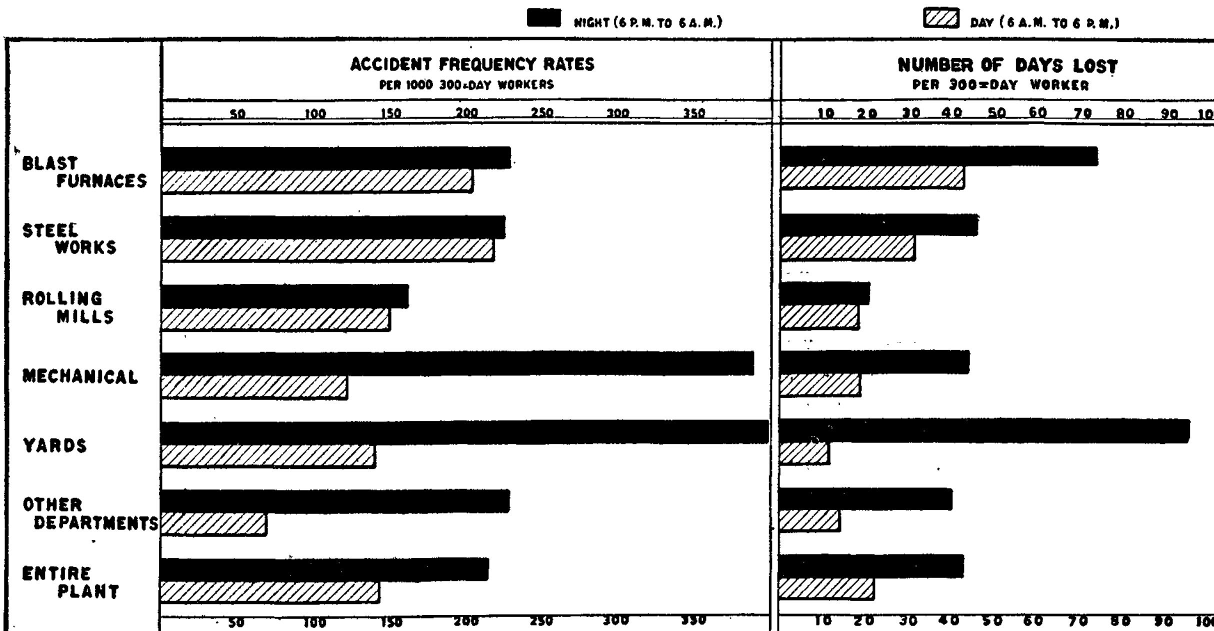


Year	Frequency rates.	Severity rates.	Number 300-day workers
1905	385	58.1	1,544
	219	24.5	4,862
1906	299	97.4	1,801
	163	40.0	5,693
1907	265	53.9	1,897
	149	29.4	5,688
1908	147	26.0	1,129
	142	32.1	3,446
1909	229	38.6	1,647
	146	17.5	4,568
1910	165	28.2	1,998
	116	16.8	5,644
1911	116	25.8	1,559
	104	15.6	4,215
1912	184	21.3	2,094
	139	11.5	5,302
1913	139	32.8	2,003
	101	15.4	5,559

operative grounds. Some hurriedly improvised lighting must be supplied. The probability that it will be unsatisfactory is very great.

CHART 12.—NIGHT AND DAY ACCIDENT RATES IN A LARGE STEEL PLANT, BY DEPARTMENTS.

[Frequency rate here means number of accidents per 1,000 300-day workers; severity rate here means number of days lost per 300-day worker.]



Department	Accident frequency rates	Days lost per 300-day worker	Number 300-day workers
Blast furnaces (night)	229	74.6	2.879
Blast furnaces (day)	204	42.6	6.413
Steel works (night)	224	46.2	3.638
Steel works (day)	218	30.5	5.045
Rolling mills (night)	160	21.1	6.516
Rolling mills (day)	150	18.1	10.789
Mechanical (night)	389	44.3	556
Mechanical (day)	122	19.1	7.767
Yards (night)	399	95.4	874
Yards (day)	139	11.7	5.083
Other departments (night)	227	40.4	1 209
Other departments (day)	69	14.8	9.880
Entire plant (night)	214	43.2	15.672
Entire plant (day)	142	22.2	44.977

This need for emergency lighting is a point to which lighting engineers should give further attention.

The extremely high night accident rates in yard operations must be very largely due to the difference in lighting. The moving of cars, the loading and unloading, and the shifting of materials which go on at night must be greatly dependent for their safety upon lighting which enables the worker to avoid the obstacle over which he may stumble and to place properly the objects which he handles.

EXPERIENCE IN THE DÜSSELDORF DISTRICT, GERMANY.

In the Archiv für Soziale Hygiene (Leipsic, 1910. Band VI, Heft 1, p. 87) Dr. Walter Abelsdorff presents the following table in regard to accident rates for the Düsseldorf district of Germany:

TABLE 58.—DAY AND NIGHT ACCIDENT RATES FOR SPECIFIED INDUSTRY GROUPS IN THE DÜSSELDORF DISTRICT, GERMANY.

Industry group.	Plants operating day and night shifts.	Number of workpeople.		Number of accidents.		Frequency rates (per 1,000,000 hours' exposure).	
		Day.	Night.	Day.	Night.	Day.	Night.
Mining, blast furnaces, steel works	92	45,062	16,657	8,609	3,522	64	70
Quarrying and excavating	54	2,951	1,317	244	57	28	14
Metal working	15	3,692	1,658	661	181	60	36
Machine building, tools, etc	14	2,849	697	542	143	33	70
Chemical industries	31	8,865	1,410	465	119	17	28
By-products from timber	50	1,810	460	167	33	30	24
Paper making	9	776	338	72	11	31	11
Food products	18	536	209	27	7	17	11
Total	283	66,541	22,746	10,787	4,073	54	60

A comparison of rates in this table with those in the preceding table is not possible since the definition of accident used in the German experience is not the same as that used in this report.

The iron and steel industry and mining taken together show a higher rate at night. In the text of the article from which the table is taken it is stated that in large iron and steel works the night rates exceed the day rates in the proportion of 218 to 188. A comment is quoted from a Düsseldorf official to the following effect: "Large iron and steel works lead in respect to special risks to night workers." His explanation is insufficient illumination and less rigorous supervision.

A comparatively small group of machine builders shows the same tendency to higher night rates, as do also the chemical workers.

For the main industrial groups presented this German experience is like that of the majority of the American plants examined.

CONJUGAL CONDITION AS INFLUENCING ACCIDENTS.

The question sometimes arises as to whether marriage and the having of dependents have any influence upon the worker in making him more careful in the avoidance of accidents.

No special study of this subject was made in the course of the present investigation. But, as still pertinent, the results of a study presented in the earlier report on accidents in the iron and steel industry is reproduced below in tabular form.[62] The table contrasts, over a series of years, the accident frequency rates of married and single men. The information was obtained from a large steel plant having records on this point, and was limited to persons in the age group 30 to 39 years in order that assurance might be had that the hazards were substantially the same for all of those included.

TABLE 59.—FREQUENCY OF ACCIDENT OCCURRENCE IN A LARGE STEEL PLANT, BY CONJUGAL CONDITION, 1906 TO 1910, BY YEARS.

Year.	Number of workers.		Number of accident cases.		Accident frequency rates (per 1,000,000 hours' exposure).	
	Married.	Single.	Married workers.	Single workers.	Married workers.	Single workers.
1906	1,590	457	299	76	62.7	55.4
1907	1,827	429	288	80	52.5	62.2
1908	882	360	149	31	56.3	28.7
1909	1,350	347	224	60	55.3	57.6
1910	1,895	376	235	41	41.3	39.7
Total	7,544	1,969	1,195	288	52.8	48.8

The number of single men in each of the years is rather small, but the constancy of the accident rates indicates that such rates may be accepted as fairly typical. The rates for the married men, it will be noted, are higher in three of the five years and also slightly higher for the combined period—52.8 as against 48.8 cases per 1,000,000 hours' exposure. These differences are not sufficient to afford ground for concluding that either group is possessed of constant characteristics tending to give it a different rate from the other.

POSSIBLE INFLUENCE OF USE OF ALCOHOL UPON ACCIDENTS.

Safety men are thoroughly convinced of the importance of alcohol as a contributing cause of accidents. To this conviction the resolutions which they have adopted and the propaganda they have started bear emphatic witness.[63] In the present study an earnest effort was made to get at the ground of this conviction and to learn whether there was a substantial basis for its existence. But information of any value on this subject was obtainable in only one plant. In this plant the night accident rates were found to be higher than those of the day. The superintendents, without exception, were of the opinion that alcoholic excess was partly responsible. The points of their argument were these: (1) The smuggling of liquor into the plant is more possible by night than by day; (2) a workman quitting the day turn will, if he uses liquor, be apt to do so in the evening before going to bed; (3) on the other hand, a man who uses liquor, quitting in the morning, will be likely to get to sleep quite promptly, and then, waking some hours before his turn begins, will drink at that time, and so come to the mill under whatever immediate effect it may have. The superintendents regarded the frequent

[62] Report on Conditions of Employment in the Iron and Steel Industry in the United States (S. Doc. No. 110, 62d Cong., 1st sess.), Vol. IV, p. 168.
[63] See Proceedings of National Safety Council, 1914, pp. 158, 159, 221.

appearance of high rates in the early night hours as confirmatory of their views.

It will be recognized that the determination of the influence of alcohol upon accidents is exceedingly difficult. In a given injury the mechanical elements, such as tools or falling objects, can be determined, but the relation of personal condition to the occurrence is very complex and practically impossible of exact determination.

In the case of the plant now under consideration the supervisor of labor suggested that the records of disciplinary action, kept in detail in this plant, might shed some light upon the question whether alcoholic use was or was not more prevalent on the night turn. Thereupon these records were tabulated, with the following result:

TABLE 60.—DISCIPLINE IN A LARGE STEEL PLANT FOR USE OF ALCOHOLIC INTOXICANTS.

Year.	Number of workers.		Number of cases of discipline.		Discipline rates (per 1,000,000 hours' exposure).	
	Night.	Day.	Night.	Day.	Night.	Day.
1907	1,897	5,688	41	26	7.1	1.5
1908	1,129	3,446	44	11	12.7	1.1
1909	1,647	4,568	40	6	8.1	.4
1910	1,998	5,644	47	12	7.8	.7
1911	1,559	4,215	43	18	9.2	1.4
1912	2,094	5,302	28	28	4.5	1.8
1913	2,003	5,559	33	19	5.5	1.1
Total	12,326	34,422	276	120	7.5	1.2

The above table shows very clearly that in cases of rules violations sufficiently pronounced to be detected and disciplined the night rate was very much in excess of that for the day. Since the same diligence of enforcement was observed by the management by day as by night, there can hardly be any other deduction than that rules violations were of greater prevalence at night. This is not, it may be noted, an inference regarding relative quantities of alcohol consumed by day and by night, but simply one regarding the time of consumption and its possible effect on the accident rate.

There is another feature worth noting. For the day turn the discipline rates remain about the same throughout the period, but for the night rates there had occurred a marked reduction—from 7.1 cases in 1907 to 5.5 cases in 1913. If this decline in rates of discipline represent a reduction in the use of alcohol, it must in part account for the fact of the more rapid reduction of night accident rates which took place in this plant.

DISTRIBUTION OF ACCIDENTS THROUGH THE HOURS OF THE DAY.

Table 61 presents the information as to distribution of accidents through the hours of the day which has been accumulated during this investigation. It includes several groups from the iron and steel industry and a large machine building plant.

TABLE 61.—DISTRIBUTION OF ACCIDENTS IN THE IRON AND STEEL INDUSTRY AND IN MACHINE BUILDING THROUGH THE HOURS OF THE WORKING DAY.

Hour beginning at—	Iron and steel plants.					Machine building plant.	Total.
	161 small plants (2 years).	122 large plants (2 years).	Large company, 4 plants (2 years).	Large plants (6 years).	Miscellaneous plants (5 years).		
Day turn.							
6	75	369	79	189	656	39	1,407
7	190	846	145	406	1,305	449	3,341
8	252	1,111	201	430	1,619	601	4,214
9	*300*	*1,209*	*244*	*489*	1,840	*787*	*4,869*
10	223	1,109	193	456	*1,949*	693	4,623
11	154	650	170	294	1,879	494	3,641
Total, forenoon	1,194	5,294	1,032	2,264	9,248	3,063	22,095
12	123	524	117	239	709	304	2,016
1	221	959	187	508	1,433	547	3,855
2	223	*1,076*	*220*	*523*	*1,684*	*617*	*4,343*
3	*240*	1,000	188	472	1,682	522	4,104
4	153	780	144	385	1,594	362	3,418
5	82	432	105	219	1,160	109	2,107
Total, afternoon	1,042	4,771	961	2,346	8,262	2,461	19,843
Total, day turn	2,236	10,065	1,993	4,610	17,510	5,524	41,938
Night turn.							
6	66	355	97	228	839	62	1,647
7	*79*	*416*	103	245	*851*	*73*	*1,757*
8	70	408	*107*	232	*851*	63	1,741
9	63	361	102	*256*	752	68	1,602
10	48	375	99	217	753	52	1,544
11	48	240	64	188	710	33	1,281
Total, first half night	374	2,155	570	1,366	4,756	351	9,572
12	*48*	209	*104*	139	433	15	948
1	43	*294*	99	212	493	*50*	1,191
2	36	276	81	*269*	574	42	*1,278*
3	46	251	90	194	*584*	35	1,200
4	37	254	85	179	546	27	1,128
5	33	262	62	167	609	30	1,163
Total, second half night	243	1,546	521	1,160	3,239	199	6,908
Total, night turn	617	3,701	1,091	2,526	7,995	550	16,480
Grand total	2,853	13,766	3,084	7,136	25,505	6,074	58,418

Table 61 presents in most of its elements and in its total an arrangement which, so far as the iron and steel industry is concerned, may be regarded as typical. These characteristics are: (1) A larger number of accidents in the first portion of the working interval than in the second; (2) in each portion the accident cases rise to a peak and then decline.

The tendency which brings about this form of distribution is manifestly slight, since it appears in more and more marked form as the groups tabulated become larger. This is exactly what should be expected if in determining the distribution there is operative some slight but constant influence.

In the effort to interpret these curves of distribution one encounters at once two serious difficulties: (1) It may be that the employees arrive and leave in such a way that the rising curve simply follows an increasing number of employees on duty and a falling curve represents withdrawal; (2) There is a possibility that there are constant errors in the reporting of the hours of accident occurrence which tend to give form to the curve and to obscure the real distribution.

Regarding these difficulties the following statements may be made. In a continuous industry like iron and steel, where the workers are often paired off, the one on duty not leaving until his "buddy" has arrived to take his place, the tendency would be toward a uniform working force. The records of consumption of electric power in such mills seem to indicate substantial uniformity. The records of arrival and leaving for one large plant were secured with the intention of tabulating them. It proved to be so time consuming a task that the work was not completed, but as far as it was possible to carry it, it did not appear that the variations of the employment curve were sufficient to account for the accident curve. The accident shift in the course of the working period is doubtless in some part a response to a changing number of workers, but this influence is by no means sufficient to account for the entire movement of accident curves.

It is evident that there is a definite tendency to record the time of accident occurrence as of the nearest hour. For example, in arranging 1,600 cases to the nearest five minutes as reported, it was found that 52 per cent were set down as having happened exactly on the hour and 26 per cent at 30 minutes past the hour. This tendency to set down the nearest hour would tend to produce congestion at points having a full half hour both before and after them. Such points are 8, 9, 10, and 11 in the forenoon and 2, 3, 4, and 5 in the afternoon. When the cases recorded as of these hours are separately tabulated they show curves in all respects similar to those obtained by tabulating all the reported hours.

It seems probable that in establishments which give some attention to accuracy in reporting the hour of occurrence and particularly where there is a double record, such as a foreman's report and an emergency room notation, which can be checked against each other, the tabulation of the recorded hours gives a substantially correct indication of distribution although the individual records may not be correct to the minute. Any attempt to use smaller divisions of time than one hour would certainly give unreliable indications.

The reporting of the hour to public agencies must be regarded as so liable to error that dependence can not be placed on their records. It is evident from observation of reporting methods that from time to time the hour figure is filled in from memory considerably after the time the fact occurs. Under such circumstances the occurrence will very likely be correctly located in the part of the day, but the tendency will be to assign it to an hour somewhere near the middle and so artificially to increase the peak in that vicinity.

It was thought to be desirable, with the material represented in the last column of Table 61, to test the question whether the severity of accidents would show a distribution similar to that shown by the frequency. It was found that while the peak in number of cases is reached in the hour beginning at 9 o'clock in the forenoon the highest severity is found in the hour beginning at 11, closely followed by the hour beginning at 7. The other hours are entirely irregular. In the afternoon the frequency peak is in the hour beginning at 2 o'clock, while severity reaches its climax in the hour beginning at 3.

It is evident either that the forces which determine the curve of accident cases are not sufficiently strong to influence the distribution of severity or that the volume of data is insufficient to disclose any law of distribution. It seems likely that, since the cause of severe injury is very often some obscure defect in the apparatus which is likely to become evident at any time, the effect of a very large volume of data would be to show a practically uniform distribution of severity.

RECENT STUDIES IN DISTRIBUTION.

The United States Public Health Service has recently issued a bulletin (No. 106)[64] devoted to a detailed study of what is undoubtedly the largest and most carefully gathered body of data ever assembled on this subject. Since the new matter included in this publication suggests a review of the material contained in Bulletin No. 234 of the Bureau of Labor Statistics the consideration of them will be combined.

It has long been clear that for any sort of understanding of the significance of accident curves through the hours of the working day it is necessary to know not only the accident distribution but the facts regarding production from hour to hour in the same processes. Accordingly, opportunity was sought to secure such information. It hardly need be said that this is very difficult, since it is not usual to maintain such records by hours. Finally it was found that a group of mills for which the accident distribution was known over a period of years were making from day to day a record of hourly output. This was not usually preserved for any considerable period but on request the records were kept. The following table shows the result in detail and the chart shows how a curve for all the mills combined compares with the accident curve of the same mills.

TABLE 62.—PER CENT OF TOTAL PRODUCTION OF DAY TURNS ACCOMPLISHED DURING EACH SPECIFIED HOUR OF EMPLOYMENT IN NINE MILLS OF A STEEL PLANT, SEPTEMBER, 1912, TO APRIL, 1913.

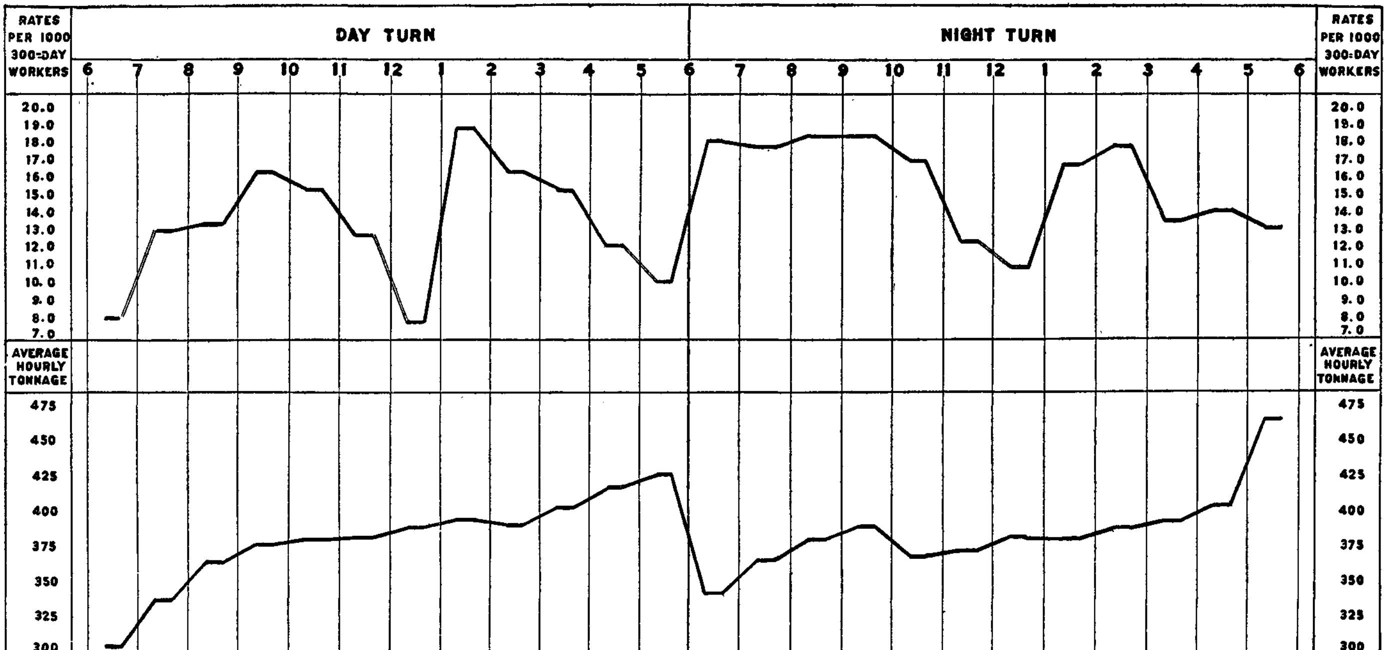
Hour ending at—	Bessemer converter.	Blooming mill A.	Blooming mill B.	Slabbing mill.	Rail mill.	Structural-iron mill A.	Structural-iron mill B.	Plate mill A.	Plate mill B.
8 a. m.	8.14	6.37	6.43	6.97	8.21	6.74	5.78	8.18	8.23
9 a. m.	8.22	8.02	8.20	8.10	7.82	6.96	7.25	8.24	8.50
10 a. m.	8.18	8.31	8.62	8.07	8.36	8.24	7.99	8.11	8.39
11 a. m.	8.15	8.58	8.85	8.36	8.54	8.02	8.65	8.20	7.97
12 a. m.	8.34	8.65	8.69	8.23	8.11	8.39	9.05	8.23	8.08
1 p. m. (lunch hour)	...	...	...	...	...	...	...	...	...
2 p. m.	8.44	8.92	8.53	8.61	8.85	8.70	8.50	8.64	8.41
3 p. m.	8.50	8.96	8.67	8.62	8.02	8.67	9.00	8.72	8.44
4 p. m.	8.41	9.36	9.14	8.68	8.77	9.41	9.37	8.69	8.76
5 p. m.	8.78	9.35	9.56	9.18	9.18	9.41	9.19	9.08	9.02

Theoretically fatigue should affect these curves in one or both of two ways: (1) With the onset of fatigue to any notable degree the product should decline, because of the lessened capacity of the body for precise and exact reactions, or (2) the accident occurrence should increase if, by an effort of the worker, production is maintained in spite of fatigue.

In the table and chart presented the precise opposite of these naturally expected results is shown to have occurred. Toward the end of the shift when fatigue is necessarily most pronounced the production curve is rising and the accident curve falling.

[64] Comparison of an 8-hour with a 10-hour plant. By Josephine Goldmark and Mary D. Hopkins.

CHART 13.—HOURLY ACCIDENT RATES AND HOURLY PRODUCTION.



NUMBER OF 300-DAY WORKERS { DAY 12,407
NIGHT 6,875 }

TOTAL PRODUCTION (TONS) 1,910,003
TOTAL ACCIDENTS 3,307

It is perfectly clear that in such mills as those under consideration there is great opportunity for the intrusion of other factors than the personal condition of the worker which may determine the course of production and mask entirely the effect which fatigue must necessarily have.

The only other information which the authors of Bulletin No. 234 were able to secure was the record of output for stamping presses which were equipped with automatic counting devices. It was not possible to extend this count over a long period nor to include a great number of machines. When, however, these presses showed the same increasing product from hour to hour as that shown by the steel mills, it was impossible to reach any other conclusion than that embodied in the following quotation (p. 154):

> It is not possible to show that fatigue is anywhere distinctly registered in the curves which have been plotted. The chief practical outcome of the study has been to call attention to the prevalence of high rates at night and to emphasize the necessity of adequate lighting and other measures tending to greater safety in night work.

It was by no means the intent of the authors of Bulletin No. 234 to "abandon" fatigue as a factor in the situation but simply to point out that it was masked in the curves that developed from the material at hand. With this in view they offered a "provisional explanation" applicable to the case as it stood but subject to modification should later study show that their material was exceptional. Further comment will be made after presenting the more recent results.

The United States Public Health Service Study.—The study presented in Bulletin No. 106 is based upon material gathered in two large establishments in which the investigators were given every possible opportunity to assure themselves of the accuracy of the basic records.

The results which are of present interest are embodied in four charts. Three of these are based on observations made of three types of work, namely, machine work, dexterous hand work, and muscular hand work. The fourth is a composite chart covering the experience of one entire plant. This last, as including much the larger body of workers and the greater number of accidents, is chosen for reproduction in a changed form here. It is projected on a logarithmic scale as being both easier to read and as expressing more exactly the important fact, which is the rate of change from hour to hour.

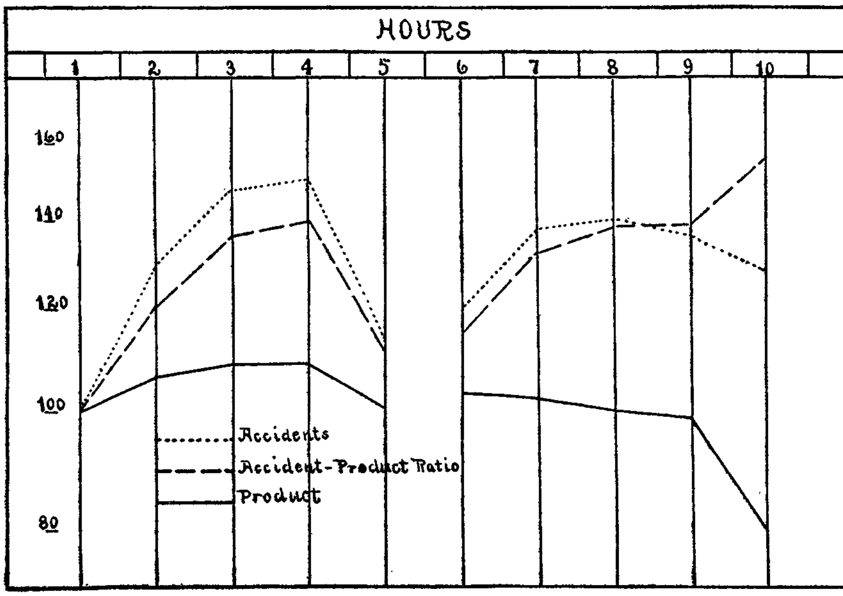
Inspection of the chart will show that the accident curves are substantially the same as those of the data assembled and published by this bureau heretofore. It is a fair guaranty of the essential accuracy of these earlier compilations, gathered under conditions precluding the application of certain precautions regarding accuracy, that they so closely resemble these in which greater care was possible.

Chart 13, based on steel-mill data, shows a rising production through the entire day turn and nearly as constant a rise during the night turn. A similar condition appeared with the small group of press hands. These two compilations were all that was available when Bulletin No. 234 was completed. Chart 14 shows an accident rate curve in essential agreement with the curve shown in Chart 13. The production curve is quite different. It rises during four hours of the morning spell and then declines. There is a slight recovery in the first hour of the afternoon, followed by a decline which becomes notably rapid in the last hour. Toward the close of the day the accident rate is falling and the product is falling still more rapidly. As a result the accident-product ratio increases.

The constancy of these results in the various conditions under which test was made raise a probability amounting almost to certainty that such a decline in product would be found to occur in all similar operations and that this decline is due to the influence of fatigue.

The relations between the accident and production curves disclosed for the departments of the steel plant must be regarded as typical for such plants until it can be shown that in similar mills a different distribution has prevailed for a period sufficient to be fairly comparable with the mills here presented. Evidently in this case other

CHART 14.—HOURLY VARIATION IN ACCIDENTS, ACCIDENT-PRODUCT RATIO, AND PRODUCTION IN A MUNITION PLANT.



factors influence the situation to such a degree that the effect of fatigue is completely masked.

In the case of the press hands discussed in Bulletin No. 234 the extent of the data both in time and in quantity is so small as compared with that shown in Bulletin No. 106 that the fact that the two compilations are not accordant can not be regarded seriously. The more recent data are so extensive and so carefully gathered that the conclusions based upon them must be regarded as having a substantial basis.

Bulletin No. 106 seems to establish very firmly the fact that fatigue is an influential factor in determining the distribution of accidents through the day. Some statements regarding it, however, require qualifications which the authors have not made.

For example, in the general conclusions are these: "(*a*) In the absence of fatigue, accidents vary in direct proportion to speed of production. * * * (*d*) The level of accident rates varies inversely with the experience of the worker." Statement (*a*), in the unqualified form given, is not consistent with statement (*d*).

The experienced worker has characteristically a high speed of production and a low accident rate. The beginner has low production speed with a high accident rate. These relations are wholly apart from and independent of fatigue. With the beginner it is not his speed but his effort at speed combined with his lack of skill which has disastrous results.

If, as seems established both by laboratory test and shop experience, there is a period with every worker beginning a task in which he passes from a condition resembling a beginner to the full value of such experience as he may have attained this change not only may, but must, have some influence on the curve of accident distribution. The suggestion, based on the inadequate data regarding press hands, that this "recovery of skill" might extend into the afternoon is probably, in view of the later developments, not reasonable. This should not lead to omitting it entirely from consideration. It still seems reasonable to urge that the following statement in Bulletin No. 234 (p. 159) is valid to some undetermined point during the morning hours:

> At the outset of any effort there is a certain lack of harmony between the will and the nervous and muscular agents by which results are attained; the coordination is not perfect. If along with this imperfect coordination there is some motive, of whatever character, leading to effort for increased speed * * * the product will rise and the accident curve will rise more rapidly.

Such a rising product with a more rapidly rising accident rate to some point in the morning spell is a conspicuous feature of Charts 13 and 14.

It is distinctly unfortunate that the authors of Bulletin No. 106 should have chosen to designate their "accident-product ratio" as the "accident risk." Risk is something which pertains to workers rather than to product. It has happened in the past that the rate of accident "per 1,000,000 tons mined" has been presented as evidence of improving conditions, when the actual risk to the men was materially increasing. The "accident-product ratio" does not in itself disclose the risk to the men and should not be presented in a form to suggest that it does.

In fact, different portions of the curve corresponding to the "accident-product ratio" must have a different significance. For example, in the forenoon a rising product is accompanied by a rising accident-product ratio; in the afternoon a declining product is accompanied by a similarly rising ratio. There is no reason for thinking that this course of the ratio has the same significance in both cases. The morning rise must be largely due to the readjustment of the worker to his task, already mentioned, while the afternoon rise is doubtless in correspondence to developing fatigue.

CHAPTER VIII.—"ENGINEERING REVISION."

The safety man has been too much occupied with the urgent problem of meeting the immediate situation to take many long looks ahead. From time to time there has arisen in his mind the interesting question "How far am I expected to go?" "Is it reasonable to look forward to a time when serious accidents will have become so few that their occurrence will be a matter of surprise or must we look forward to a constant and huge toll of human life and limb from year to year?"

Until very recently it has been the prevailing belief that practical elimination of serious and mortal injury could not be regarded as something even to be hoped for. The study of accident causes which has occupied the preceding chapters suggests very pointedly that while the minor accident which causes a few days' disability must probably continue in some degree, it is the privilege and duty of industry to make its conditions so safe that serious injury will be of exceptional occurrence. This conclusion is based on close analysis of the experience of the iron and steel industry, but in a broad way it should be applicable to all industry.

Before presenting the evidence regarding the importance of "engineering revision" it is necessary to indicate carefully just what is meant by the expression. While it is steadily gaining recognition as a useful expression, it is still new enough to require some explanation.

It was devised to include in a single brief expression the widest possible application of engineering skill to the safety of industrial plants. It would include the design and location of the buildings with special reference to the necessary connection with transportation facilities, ready and safe access to every point where workers must go, the provision of adequate and properly arranged lighting, the provision of machines designed from the safety standpoint and the guarding of such machines of faulty design as the plant was unfortunate enough to have, and proper attention to all dangerous conditions. It is a fact that safety men themselves are hardly aware of the extent of the changes which have gradually occurred under their supervision. It is much more impressively evident to one who saw conditions before the safety man began his work and who returns after an interval and notes the transformation.

Why should so obviously important an item in the accident prevention effort have been relegated to a secondary place and even regarded as having only temporary importance? There are two reasons which have been most influential:

(1) Accident prevention has grown out of the system of employers' liability. Under that system it was necessary for the employer for self-protection to make the most of his possible defenses, of which the most important was negligence on the part of the worker.

It has not been possible thus far to escape from that habit of mind which ascribed much to the "carelessness" of the worker and stressed little the importance of safe tools, safe machines, safe practices, and safe construction. Carelessness and ignorance on the part of the worker are a prolific source of minor injury. The organization of safety committees and the active propaganda undertaken in the interests of safety had an immediate and striking effect in reduction of minor injury. With it went a moderate decline in severity, due, as will be shown, mainly to engineering changes. It sometimes happened, however, that in the midst of conspicuous success in removal of minor cases an actual increase in the severer injuries occurred. It is not too much to say that if personal carelessness were entirely eliminated the effect upon serious and fatal cases would be slight if the engineering defects went unremedied.

(2) Until very recently safety men and accident statisticians have confined attention to the frequency of accidents and have used no method by which changes in severity could be easily detected and remedies suggested. The vast majority of the accidents occurring in the iron and steel industry are of minor character. When those producing disabilities not extending beyond the day of the accident are left out of account nearly or quite 50 per cent of all injuries reported caused disabilities terminating in one week or less. In spite of their number these short-term disabilities are of comparatively small importance from the standpoint of severity. The accidents resulting in death, although constituting only about 1.5 per cent of the total number of accidents, caused a total loss of time amounting to more than 65 per cent of the total time losses caused by accidental injuries.

In order to study the influence of various methods in controlling accident occurrence it was necessary to develop and apply a method of severity rating such as that described in Chapter II. The essential feature of this method is the use of a scale of equivalents, expressed in terms of work days lost, for such cases as death, loss of hand, etc. For example, the average age of those killed in industry is about 30 years. At 30 years the expectation of working life is about 20 years or 6,000 working days. This figure is accordingly used to translate the fatal cases into terms the same as those which determine the severity of temporary disability.

By a study of the severity rates resulting from the application of this method in plants where the structural changes which had occurred during the same period were known it became possible for the first time to get some measure of the influence of such changes.

It is proposed now to show that in many cases it is possible to connect directly certain items of "engineering revision" with definite improvement in the severity rates and to contrast these changes with the corresponding changes which may be attributed to the exercise of greater personal caution.

The material will be presented under three heads: (1) Departments of the iron and steel industry; (2) deaths in the industry; (3) nature of injury causing death.

ACCIDENT CAUSES, BY DEPARTMENTS, OVER A PERIOD OF YEARS.

BLAST FURNACES.

In the blast furnaces under consideration hot metal "breakouts" contributed to the severity rate more largely than any other cause in the early years of the period. From 1910 onward this cause practically disappears. Its disappearance was due to structural changes which increased the resistance of the furnaces to such an extent as to eliminate the breakouts.

Second in importance as a cause of serious accident in the earlier years was asphyxiating gas. Breakouts and gas furnished 50 per cent of the severity rate in 1906. The situation regarding gas has been improved mainly by such structural improvements as carrying the gas mains high in the air and providing more effective control by means of improved valves. In addition protective devices, such as oxygen helmets, have been provided for use when it is necessary to go where gas is necessarily present.

When examination is made of the accident rates for those causes which are more affected by the personal care of the worker, it is evident that while accident reduction of great importance has occurred it does not approach in significance that arising from the control of the above causes to which engineering revision was applied. For example, "falls of worker" may be regarded as greatly influenced by personal care. In these blast furnaces the severity rate reduction was 0.47 day (i. e., from 1.87 days to 1.40 days lost per 1,000 hours' exposure) between 1906 and 1913. This may be compared with a reduction of 14.71 days in case of injuries due to hot substances (i. e., from 15.14 days to 0.43 day) and a reduction of 2.50 days (i. e., from 3.83 days to 1.33 days) in the case of injuries due to asphyxiating gas.

Even these statements do not present the case fully. In the early days there were one or two deaths annually from falls of painters engaged upon the stacks or stoves. The provision of a suitable sling and seat for painters has entirely eliminated such deaths. Furthermore a considerable portion of the reduction of 0.47 day for falls of worker may be attributed to such mechanical contrivances as safer ladders, railings on runways, and similar provisions.

Personal care must be very important in the reduction of accidents due to handling objects and tools. In frequency the decline was notable but in severity it was but 0.30 day from 1905 to 1913, an amount altogether insignificant when compared with that produced by engineering change in hot substances and asphyxiating gas. It must not be forgotten that part of this small saving was the result of better engineering in the matter of safer tools kept in better condition.

From whatever point considered these blast furnaces give evidence of the high importance of engineering revision in bringing about reduction of accident severity.

OPEN HEARTHS.

In the open-hearth department injuries caused by cranes show high severity in the earlier years, particularly in 1907. This can be connected directly in a number of cases with structural defects then prevalent, such as absence of footwalks, poor access to the crane cage, and overhung gears. By 1911 these defects had been largely corrected and severity rates dropped markedly and continuously.

In injuries caused by hot substances, explosions other than ingot are the main cause of the early high severity rates. It is obvious that the carefulness of the individual workman can do little to prevent such explosions. When they occur some workmen are inevitably killed or injured more or less severely. There is rarely any warning to enable those exposed to escape. The lessened severity rate of recent years is mainly due to revisions in structure and in method which were primarily introduced to favor production. They both lessen the likelihood of explosion and protect the worker when explosion comes. These structural revisions have not been rated at their true value from a safety standpoint because, as stated above, they are almost all related to production.

The reduction of the severity rate for injuries due to power vehicles must be largely attributed to improved transportation facilities.

The cause groups noted above are obviously those in which engineering revision might be expected to show the largest results. This expectation is fully borne out by the figures combining these groups. They show a decline from 13.0 days in 1907 to 2.3 days in 1912, or 82 per cent. In such cause groups as "handling objects and tools," where personal care is a larger factor, the decline was little or nothing.

If frequency is considered the showing is very different. The cause groups dependent on engineering improvement declined in frequency rates from 39.3 cases per 1,000,000 hours' exposure in 1907 to 21.5 cases in 1912, or 45 per cent. From 1907 to 1914 "handling objects and tools" declined 50.3 per cent. On the basis of frequency personal care had decidedly the better record. How completely the record is reversed when severity is considered is emphasized when it is remembered that while "handling objects and tools" was making the notable reduction of 50.3 per cent in frequency, this cause group showed no decline in severity.

ROLLING MILLS.

In heavy rolling mills the only cause of injury about which it is possible to make a positive statement is the overhead crane (see Table 27). The reduction in severity rates recorded is mainly due to better cranes, better chains, and improved operative methods.

Of tube mills it may be said that the lessened severity rates may very properly be attributed in considerable measure to increased personal care. In such mills there are many opportunities to eliminate moderately severe accidents by greater skill and care on the part of the men. Fatalities do not occur often enough in tube mills to give opportunity to form a conclusion.

MISCELLANEOUS DEPARTMENTS.

In plate and sheet mills (Tables 30 and 31), in the mechanical department (Table 33), and in the fabricating shops (Table 34) it is difficult to decide which factor—personal care or engineering revision—has had the greater influence on the severity rates. Since many of the operations are of a personal and manual nature it is fair to give considerable importance to individual care. Making all allowance for these facts, it still appears that in cases of high severity many of them involved some structural defect admitting of remedy.

YARDS.

In the yard department injuries caused by hot substances show a remarkable decline in severity rates (Table 35). Most of this is clearly attributable to improved methods in the transport of hot metal.

When the power vehicle as a cause of accident is studied it becomes evident that the introduction of automatic couplers, the provision of adequate clearances, improved loading methods such as the use of magnets, better systems of signaling, and the elimination of grade crossings have been the main factors in the decline in severity which has taken place.

FATAL INJURIES.

Fatalities, when adequately weighted, are more influential than all other elements in the severity rate. It is accordingly of the greatest significance to consider the cause of such occurrences and to appraise the value of the measures taken for their prevention.

It was possible to consider 372 cases of death from this standpoint. These deaths occurred in plants employing an average of 247,038 workers. The fatality rate was 0.50 per million hours' exposure. This may be compared with 0.40 for the entire industry. Clearly these plants were not exceptional in character. The following table lists the 372 deaths by causes:

Causes of 372 cases of fatal injury in the iron and steel industry, 1910 to 1914.

Engines, motors, etc	3
Transmission gear	3
Working machines:	
Adjusting	2
Operating	2
Oiling and cleaning	2
Repairing	5
Objects flying	4
Miscellaneous	2
Total	17
Cranes and hoists:	
Operating	1
Oiling and cleaning	3
Repairing	3
Breakage	7
Falling loads	23
Hoisting and lowering	8
Miscellaneous	32
Total	77
Hot substances:	
Electricity	16
Explosions	12
Hot metal	15
Hot metal flying	25
Flames	5
Miscellaneous	3
Total	76

Falling objects:	
Collapse of building, etc	9
Stored or piled materials	7
From trucks or vehicles	3
From buildings, scaffolds, etc	4
Miscellaneous	27
Total	50
Falls of worker:	
From ladders	5
From scaffolds	6
From vehicles	1
From structures	20
From other elevations	4
Into openings	3
Miscellaneous	6
Total	45
Handling tools and objects:	
Tools in hands of worker	1
Loading and unloading	3
Objects flying from tools	1
Total	5
Power vehicles	57
Miscellaneous:	
Flying objects not otherwise specified	4
Asphyxiating gas	19
Heat	4
Moving objects not otherwise specified	6
Miscellaneous	6
Total	39
Grand total	372

It is necessary to state the principles upon which the following interpretation of these death cases rests:

First. It is assumed that it is the primary duty of the safety man to make conditions safe rather than to educate the men to avoid unsafe conditions over which they have no control. In considering any given case, if it appears that the immediate cause of the accident was some weakness in an appliance, or faulty construction, or poor arrangement, which, if remedied, would have prevented the injury, no amount of so-called "contributory negligence" on the part of the man is considered sufficient to transfer the responsibility to him.

Second. The fact that an apparatus can be used with entire safety by the exercise of special care is not regarded as excusing the failure to provide safer apparatus. For example, a ladder without safety feet may be used on a hard floor by taking certain precautions. If a man falls and is killed under such circumstances the unsafe apparatus is regarded as the point to be considered rather than the failure to take the possible precautions.

Third. The costliness of remedying structural defects, even to the extent of entirely reconstructing a mill, should not bar its consideration.

The cause groups of the table will now be followed and commented upon in the order in which they appear:

Engines and motors caused three deaths. Two of these could have been avoided by the guarding or removal of projections on the moving parts.

Transmission gear caused three deaths. Two of these were due to projecting set screws on shafts.

In working machines, 9 out of 17 deaths were due to mechanical or other conditions which should have been remedied and over which the operator had little or no control.

Cranes and hoists were the cause of the largest number of fatalities—77. One which occurred in operating a crane was due to some defect in the electrical control of the crane. Three, which were of oilers, were attributable to the necessity of approaching moving parts not properly guarded. Seven due to breakage were all preventable by proper design or greater strength. Of 23 due to falling loads, some weakness in the crane, imperfect chains, faulty signals, or some other condition which the management should have improved was a factor in all but one case. Some of these involved an element of contributory negligence, but if this had not been combined with mechanical defects no accident would have occurred. Miscellaneous causes incident to cranes and hoists contributed 32 cases, of which 10 were clearly due to defects such as absence of footwalks and of proper means for reaching the crane cage. To sum up, 43 out of 77 cases in the operation of cranes and hoists could have been prevented by better design in the crane and such operating methods as now prevail. It may be strongly suspected that into the other 34 cases there entered not infrequently elements of unsafe practice or imperfect structure for whose presence the workers were not responsible and which no education of them could remove.

Hot substances caused 76 fatalities. Sixteen of these were due to electric burns, and of these 13 were preventable by the kind of construction now in common use in electrical installation. Of 12 deaths due to explosions, 7 were of a kind which could scarcely occur at present with the improved modern practices. Hot metal caused 40 deaths, and in 32 of these bad method or imperfect structure had a part. For each condition under which these 32 cases occurred an effective remedy has been found. It should be emphasized that this does not mean teaching the men caution. It means a correction of faults in the apparatus and in methods of using it. Not fewer, therefore, than 52 out of the 76 deaths due to hot substances presented problems of revision of structure and methods.

Of 50 deaths due to falling objects 29 were preventable by appropriate structural changes.

Falls of worker caused 45 deaths. Of these 22 might have been prevented by better scaffolds, stairs, platforms, railings, and other structural provisions which are now regarded as a matter of course.

Of 57 deaths due to power vehicles 34 were the result of causes such as the following: Failure to install automatic couplers, inadequate clearance between cars and buildings, grade crossings upon which men could come without being able to see the approaching locomotive, bad signal systems which permitted cars to be shunted down upon standing cars under which men were at work, and absence of proper grab irons for getting on and off cars. None of these present any insuperable difficulties to the engineer..

There were 19 deaths from asphyxia. All of these were related to imperfect gas mains, unventilated inclosed spaces, leaky valves, and other conditions involving changes in the apparatus.

To summarize this examination, 212 out of 372 deaths, i. e., 57 per cent, could have been prevented by some engineering revision. This can be said without qualification. It can not be said that all the other 43 per cent would have been amenable to educational methods in response to which caution would insure safety. In only about 10 per cent of these deaths would it be safe to say positively that the man's own carelessness clearly appears as the major factor. In the remainder either no conclusion is justified by the record or there is a mixture of contributory negligence with possible structural imperfection impossible to untangle.

The above compilation of fatal injury cases represents a combination of data for the years 1910 to 1914. It is of interest to compare with it a body of material for a group of plants for the year 1916, that year being one of extraordinary activity in the industry. In this group of mills, with 84,305 workers, 72 deaths occurred. This is at a rate of 0.29 cases per 1,000,000 hours' exposure as against the rate of 0.50 for the preceding group for the years 1910 to 1914. This lower fatality rate represents a distinct improvement, the probable result of very extensive structural revision made by these plants. In spite of this improvement, however, an analysis of the 72 death cases indicates that at least 58 per cent of them involve elements of structural defect or improper operative methods.

ANALYSIS OF THE NATURE OF INJURY IN FATAL CASES.

Further light upon the possibility of reducing the number of serious accidents may be derived from a study of the nature of the injury causing death. This is desirable also because the consideration of rates and distribution from year to year comes to have a rather formal interest and fails to give due emphasis to the vital importance of these cases.

The nature of the injury causing death was available in 956 cases. In the following table they are distributed according to the nature of the injury and the part of the body affected:

TABLE 63.—NATURE AND ANATOMICAL LOCATION OF INJURIES CAUSING DEATH IN 956 CASES IN THE IRON AND STEEL INDUSTRY, 1905 TO 1914.

Nature of injury.	Anatomical location of injury.						
	Head, general.	Skull.	Scalp.	Face.	Neck.	Back.	Chest.
Bruises, cuts, lacerations, and punctures	3				1	2	5
Bruises, etc., with infection	1		6	1	1	1	1
Burns and scalds				1		8	74
Concussions	5						
Dislocations					1		
Fractures		218		3	20	13	220
Traumatic dismemberment	[1] 4						
Total	[1] 13	218	6	5	23	24	300

[1] Includes 2 cases of decapitation caused by hot rod.

TABLE 63.—NATURE AND ANATOMICAL LOCATION OF INJURIES CAUSING DEATH IN 956 CASES IN THE IRON AND STEEL INDUSTRY, 1905 TO 1914—Concluded.

Nature of injury.	Anatomical location of injury.							
	Abdomen.	Pelvis.	Arm.	Hand.	Leg.	Foot.	Not located.	Total.
Bruises, cuts, lacerations, and punctures	26							37
Bruises, etc., with infection			1	4	2			18
Burns and scalds	26		2		19		[2] 6	136
Burns, etc., with infection				1	1			2
Concussions								5
Dislocations								1
Fractures		33	6		65	7		585
Fractures, with infection			1	1	1			3
Traumatic dismemberment			6		[3] 9	4	1	24
Asphyxia							71	71
Electrocution							23	23
Heat exhaustion							7	7
Miscellaneous	3				1	1	39	44
Total	55	33	16	6	[3] 98	12	[2] 147	956

[2] Includes 4 cases of cremation by falling into a furnace or being covered by molten metal.
[3] Includes 1 case of dismemberment caused by hot rod.

The largest group in the table is that of fractures. When severe enough to cause death these involve nearly always an element of crushing injury. When the cases are closely studied there is found to be in a majority of them—it is impossible to determine the exact number—some indication of faulty structure which might have been remedied. For example, a man's life is crushed out between a moving car and a post beside the track. What was needed to make him safe? Six inches more of space—easy, almost costless, to give at the time of building, but looking so difficult and costly after construction is finished that it is not provided until after the man is killed.

Next in importance to fractures are burns and scalds, with 136 cases. Of these the most striking are 4 cases of cremation, 1 due to falling into a furnace and 3 to being overwhelmed by molten metal. In the cremation cases due to molten metal, rearrangements were worked out after the catastrophe which tend to lessen very much the chance of a recurrence of such an accident. In a large proportion of the less striking cases some structural improvement, lessening the danger, has been made subsequent to the accident.

The fact that infection was formerly a very serious menace is attested by the fact that 23 deaths occurred in which without this complication there would very likely have been recovery. None of the injuries in which it figured were in themselves of sufficient seriousness to cause death. This emphasizes very strongly the great value as a life saver of adequate emergency treatment, with sufficient insistence upon it to secure prompt report of even slight injury.

The 23 cases of electrocution were largely needless. They represent faulty installation or a method of doing work which should not be tolerated. The same statement is, in a measure, to be made regarding 71 cases of asphyxia. Sufficient care in construction and in methods of work would do away almost entirely with this death hazard.

Finally, 24 cases are presented which afford a startling climax to this presentation. These are cases of traumatic dismemberment, in which arms, legs, or heads were burned, sheared, or forcibly torn from the body. Of the nine cases of legs so lost one leg was burned off by a hot rod in a rod mill. The feet lost were ground off in the exposed gearing of the transfer tables of rolling mills. Four decapitations are recorded. Of these, two were due to being caught by the hot rod loop in the rod mills; the other two were the result of power vehicle accidents.

The question of the reasonableness of the costliest efforts to render such events impossible can scarcely be debated.

ENGINEERING REVISIONS PROPOSED BY SAFETY COMMITTEES.

The foregoing discussion has two elements of weakness: (1) It is based to a considerable extent on material pertaining to a period in which the safety movement had not gotten fairly under way. It may fairly be urged that attention would first be directed to engineering defects and that they might be expected in the course of time to become relatively of small importance. (2) The judgment of the authors may have been faulty. They were studying records, possibly imperfect, at a time so remote from the events that no verification or amplification of them was possible.

Either of these is of sufficient significance to make very important any opportunity to test the conclusions by more recent events subjected to the scrutiny of those who would have full opportunity to learn all the essential facts.

The following table, drawn from the experience of a large steel company, is accordingly of great interest.

TABLE 64.—CLASSIFICATION OF ACCIDENTS BY SAFETY COMMITTEES OF A STEEL COMPANY, 1915 TO 1917.

Disability of—	Number of cases of disabling accident.			
	Preventable by—		Trade risk.	Total.
	Engineering revision.	Care of worker.		
Six weeks and under	56	973	381	1,410
Over six weeks	16	100	48	164
Death and major mutilation	39	10	19	68
Total	111	1,083	448	1,642
	Percentage distribution.			
Six weeks and under	4	69	27	100
Over six weeks	10	60	30	100
Death and major mutilation	57	15	28	100
Total	7	66	27	100

This company has during the past eight years very carefully considered each case involving loss of time. The table is restricted to three recent years in order not to involve conditions prior to the time when safety work became somewhat standardized.

In each plant of the company the plant safety committee, in which were included the director of safety and a group of superintendents, made a careful study of the cases as they occurred. If there were peculiar or doubtful features the safety inspectors from the director's office made a special investigation, which was reported to the director and by him to the committee. In this way there was established for the consideration of the committee a reliable and exact record of the occurrence upon which to base a judgment as to the causes of the accident and as to the measures, if any, for the prevention of its recurrence.

The scrutiny did not stop there. At stated intervals the conclusions of these plant committees were taken up by the central safety committee of the company. This committee, after due consideration, would affirm the conclusion of the plant committee, return it for further evidence, or in some cases modify or reverse it.

There is probably no group of cases on record in the country which was subjected to more exacting study before the final decision was reached.

The bearing of this compilation on the question of the importance of "engineering revision" is found in the percentage column headed "Preventable by 'engineering revision.' "

It will be observed that of accidents causing six weeks' disability or less only 4 per cent could have been prevented, in the judgment of the committee, by engineering methods, in cases causing over six weeks' disability 10 per cent could have been so prevented, while in cases involving death or major mutilation the percentage was 57.

It is worthy of remark that this figure, 57 per cent, is the same as that reached in the Bureau of Labor Statistics study above mentioned. The exact correspondence is of course purely a coincidence, but a very significant one. The results of this careful study, based on fresh material with full opportunity for learning all the facts before a conclusion was reached, do not differ materially from those of the earlier study of records of which no correction or amplification was possible.

DEATH AND MAJOR MUTILATION.

Evidently the most important matters to be considered in this connection are death and major mutilation. The cost of these, adequately valued, outweighs that of all other injuries. It becomes, therefore, of great importance to consider with searching care the results of study of such cases by safety committees. For this reason the details of 207 cases of death and major mutilation, including the 68 cases in Table 64, are recorded at the end of this chapter. A sufficient description of each case is given to indicate the nature of the hazard involved.

The cases are grouped under three heads, as determined by the safety committees who considered them: (1) "Preventable by engineering revision," (2) "preventable by care either of injured or his fellow workers," and (3) "unavoidable trade risk."

In the opinion of the committees who passed upon them, 65 per cent of these cases were preventable by engineering revision, 24 per cent were preventable by care of the injured person or his fellow workers, and 11 per cent were due to trade risk.

It will be observed at once that in this group of cases the committees assign to the section "preventable by engineering revision" a considerably larger percentage than the 57 per cent so assigned in the earlier study by the Bureau of Labor Statistics and in the case of the large iron and steel company mentioned above.

This review of the findings of safety committees reenforces the conclusion reached from a study of various angles of the subject that the three main methods by which accident prevention is secured are the following: (1) Engineering revision to cut down serious and fatal accidents; (2) Supervision to reduce both serious and minor injury; (3) Instruction of the men in skillful methods of work to reduce minor injury.

ORGANIZATION.

The great success of organized safety effort in the reduction of minor injury has diverted attention from this fundamentally important matter of the engineering factor. Does the fact that it is now demonstrable that for relief from fatal injury the appeal must be to the engineer discredit organization? Not in the least. It simply indicates a direction in which organization must turn its energies. Organization and the interest it evokes lead to the discovery of structural defects and their remedy. Without organization the revision already accomplished would never have occurred. The obvious faults have been largely corrected. The determination of the more obscure must be increasingly the duty and opportunity of the engineer.

EXTENT OF REDUCTION OF ACCIDENTS.

In conclusion it is appropriate to consider in the light of the foregoing review the question of the extent to which serious and fatal accidents may be eliminated. The conviction that there must always remain an "irreducible minimum" of accident rests largely upon the idea that the main cause of such accident is human recklessness. Since a perfected humanity can scarcely be looked for in the lifetime of the present generation, the hope of an industry measurably free from accidental death has seemed an "iridescent dream."

Two things may be regarded as proved by the results of the safety movement: (1) Proper education and the development of interest among the men will go a long way in the reduction of minor injury; (2) Adequate engineering revision will reduce serious cases to an, as yet, undetermined degree.

The degree of this reduction is largely conditioned on the definition of "adequate." It is entirely possible to imagine structures and apparatus so strong, so well designed, so intelligently operated, that failure and consequent death will be the rare exception. The possibilities of improvement from an engineering standpoint are almost unlimited.

ILLUSTRATIVE CASES.

The following descriptive lists include, in addition to the 68 cases of death and major mutilation which occurred in one large steel company's plants (see p. 201), 139 cases drawn from other sources, making a total of 207. *The classification of cases follows the judgment of the committees, and no attempt is made to modify conclusions which are in some cases obviously doubtful.*

CASES PREVENTABLE BY SOME FORM OF "ENGINEERING REVISION."

Case 1.—Helper asphyxiated when he went to put stove on furnace. Pulled burner back too far. Fatal. Stop installed to prevent running burner back so far.

Case 2.—Top filler caught by elevator. He neglected to insert safety pin in starting lever, the result being that when his partner took hold of lever it moved unexpectedly. Man evidently negligent, but a safer device is possible.

Case 3.—Laborer, given permission to leave his gang for a short time, sat down on the electric rail of transfer track. Fatal. Had been warned about the rails. Track has been entirely fenced in.

Case 4.—Laborer caught between buggies when a train of buggies was pushed from the yard against the one which he was loading. Amputation of leg. Foreman did not exercise due care to see that his men were in the clear.

Case 5.—Inexperienced man working as oiler. Greasing bearing on front trucks of trolley of ore unloader. Trolley was racked back, catching head. Fatal. Recommended that machine be stopped while greasing is being done.

Case 6.—Nozzle setter was caught by molten metal when ladle of metal turned in stirrup hooks, pouring out metal which ran down into the pit side. Fatal. Trunnions have been changed so as to lower the center of gravity from 8½ inches below trunnions to 17 inches below.

Case 7.—Pipe-fitter's helper had climbed to the runway of crane to close a valve. He was caught between column and crane. Fatal. The pipe fitter was regarded as at fault in not looking out for the safety of his men when working on the crane runway.

Case 8.—Car-blocker's helper was at work under a car when engine pushed other cars against it, catching the man under the wheel. Fatal. Car blocker at fault in not putting out stop signals. Engine crew should have determined whether any one was in danger before moving cars.

Case 9.—Laborer on top of coke ovens was caught by larry car which carries the coal to the ovens. Fatal. It seems to be the case that the steam from the quenching platform blinded him and he lost his way. The committee is of the opinion that the only way to prevent such accidents is to remove the quenching from the vicinity of the ovens to a quenching station.

Case 10.—Repair man was caught by trolley of unloader when it started unexpectedly, ran to the top of the incline, broke the cables, and then slid back against the man. Fatal. This starting would have been prevented had the safety switch been pulled out and properly locked. The man had a safety padlock. The committee regard the dock management as negligent in not having called attention to the use of these padlocks.

Case 11.—Ladle liner was caught between edge of ladle and wall of shop. He had, apparently, climbed on ladle to inspect it and his weight caused it to tip over. Fatal. The committee is of the opinion that the number of foremen on this job is not sufficient to supervise the operations properly.

Case 12.—Repair man was changing insulators on the third rail at one of the batteries of a coke oven. This battery had been cut out so that the rail was dead. The car in order to get over this dead space would run at some speed and drift by. The man put his hand on the third rail while the car was bridging the gap between this battery and the next, thus making the rail alive. Fatal. Committee recommended that the cut-out be so arranged that both batteries have dead rails when it is thrown. This makes it impossible for a car to bridge over and make a supposedly dead rail alive.

Case 13.—On starting an air compressor operated by a 2,200-volt circuit the relay exploded, burning the man. Fatal. Recommended that high-voltage switches be removed from the board and that temporary steel shields be installed until removal can be accomplished.

Case 14.—Laborer cleaning up the scale car track had his wheelbarrow between the rails. Scale car struck wheelbarrow, throwing man against column. Fatal. The committee feels that the management was slack at this point or the dangerous practice of putting the wheelbarrow between the rails would have been stopped.

Case 15.—Melter's helper was assisting to set the hot metal spout at the electric furnace. Was loosening crane hook from loop of spout when it suddenly came away and he lost his balance and fell to the floor, the spout tipping over on him. Fatal. The committee regards the melter foremen as responsible for failure to have some parts of the apparatus in proper order.

Case 16.—Rigger was going with his gang to work with a locomotive crane. As he walked beside the crane he suddenly stepped in front of some cars on an adjacent track and was run down. Fatal. Recommended that cranes do not move through this busy yard under their own power but be handled by the yard engines.

Case 17.—Cinder snapper was digging away cinder and iron about monkey in order to substitute a new one. The blast had been turned off when the process began but later was turned on again. Monkey blew out and gas flames burned several, one fatally. Foreman used bad judgment in turning on the blast while men were working in position to be injured if an explosion occurred.

Case 18.—Laborer was crushed by falling ingot mold flask. It fell when a crane lifted another which was on the same car. Fatal. Foreman should have seen to it that the flasks were more securely placed.

Case 19.—Craneman opening windows in monitor of merchant mill caught hold of 6,000-volt wire. Fatal. High-tension wires are being removed to underground conduits.

Case 20.—Oiler knocked from platform of ore bridge by grab bucket. Fell into bin about 40 feet. Fatal. Rule made that no work shall be done on this platform when bridge is in operation.

Case 21.—Lidsman at coke ovens struck by chute on larry car. Fatal. Gas inspector who was on the car thought not to have been duly careful.

Case 22.—Craneman sitting down in his cab may have fallen asleep. He was found with his head against the hoist fuse terminals. Fatal. A guard should have been placed over the fuse blocks.

Case 23.—Switchman riding on footboard of engine was caught by a bar projecting from the pile of scrap at the side of the track. Loss of foot. Yard foreman should be more careful to keep yard clear.

Case 24.—Laborer stepped from dock wall onto flat car of slowly moving train. Just then the engineer slacked suddenly to test the coupling between two cars of the string. The jar caused man to fall under the wheels. Fatal. The man evidently crossed the track to reach a toilet. Such conveniences should not be placed where men must cross tracks in order to reach them.

Case 25.—Pipe fitter's helper sitting on a brace of the skip incline was caught when the skip came down. Fatal. The foreman had attached a sign to the controller of the skip hoist showing that it should not be operated. This was removed by some one unknown. Recommended that all levers and switches whose operation would endanger a workman shall be locked during the time the work is going on.

Cases 26–31.—Six men at work in blast furnace mains died of asphyxia when gas washer man was unable to close valve of water seal. Arrangements made to lock water seal valves when men are working in mains and additional valve will be installed in mains.

Cases 32–34.—Three masons at work on a ladle foundation in pit were fatally burned when furnace broke out. The furnace had just been rebuilt and was on its first heat. An explosion occurred within, blowing out the tap hole, and the metal poured out on the men. Rule adopted that furnaces shall not be put in operation until all repairs on them are completed.

Case 35.—Millwright caught by 1,000-pound weight to door of open hearth when bar with eye in end gave way. Fracture of leg, followed by infection. Fatal. Recommended that guards be placed around weights.

Case 36.—Laborer killed by fragment of heater which exploded in the shanty where he was eating lunch. Investigation showed that the blow-off valve was in bad condition. Recommended that better valves be installed and that they be inspected at frequent intervals.

Case 37.—Sheeter's helper was holding sheet in place on side of mill. To steady himself he was holding on to rail of crane runway. Crane came down, crushing hand. Loss of hand. This crane was not equipped with wheel guards in accordance with the company rules.

Case 38.—Laborer struck by engine and leg crushed. Fatal. On investigation it developed that the same foreman had had two other cases of fatal injury in his gang under similar circumstances and was not in the vicinity on any occasion. Recommended that, as these gangs are largely of elderly men, the foreman should exercise greater care.

Case 39.—Laborer assisting to replace derailed mold buggy. As the crane raised the buggy one of the molds fell over, catching the man's leg. Fatal. Recommended that molds be removed from derailed buggies before attempting to replace them.

Case 40.—Laborer assisting in removing molds from buggies. After adjusting chain to lugs of mold he stepped back on a track where a train was moving. Fatal. The switchman of the moving train should have been on front of his train or preceding it. Recommended to install better lighting at this point.

Case 41.—Laborer tightening bolts on pig machine was caught by his clothes on an axle pin and crushed against a column. Fatal. Recommended that a guard be placed along this runway. Foremen should not permit working on moving machinery.

Case 42.—Laborer crossing track was run down by coal car. Fatal. The switchman should have been in position to warn this man.

Case 43.—Laborer was struck by falling concrete chute when the manila rope holding it broke. Fatal. Recommended that wire cable be used for such purposes.

Case 44.—Lineman came in contact with high-tension wires on the pole where he was working. Fatal. Recommended that the clearance between high-tension wires be increased to not less than 6 feet.

Case 45.—Boiler maker was shifting planks of scaffold at furnace top when he lost balance and fell 90 feet to roof of cast house. One plank fell with him. Fatal. Recommended that it be made a rule that such work shall not be done without use of safety belt.

Case 46.—Laborer assisting in jacking up car for repairs. It was necessary to lower the car somewhat, and when this was done it canted over, catching the man and crushing his skull. Fatal. Recommended that track adjacent to one on which cars are being repaired be kept clear. Also that in jacking up cars they be followed with blocking and that a shore be used on side next other repair track.

Case 47.—Laborer carrying drinking water to open hearth was walking between building and narrow-gauge track when he was run down by locomotive. Fatal. Recommended (1) the installation of drinking fountains in the mills, so that men will not be obliged to carry water through the yards and mills; (2) to require switchmen to ride where they can see track in direction in which locomotive is moving; (3) to improve the lighting in this part of the yard.

Case 48.—Laborer caught by splashing metal when the ladle carried by the crane bumped against an empty ladle which was being lined near the mixer. Fatal. Recommended that ladle lining be conducted in some part of the mill where hot metal is not being constantly carried.

Case 49.—Boiler washer entered boiler 11 hours after it was taken off steam line. Part of wall fell, and he was burned by the hot dust. Fatal. Recommended that it be arranged that in washing down boiler man stand outside fire door. Also that if the wall shows bulging from the heat it be torn down and rebuilt.

Case 50.—Laborer caught between roll swinging from crane and pile of rolls on the ground. Fatal. Recommended that roll racks be installed in the yard.

Case 51.—Carpenter's helper using a belt pole to unship belt was struck in the abdomen when pole caught in the belt. Fatal. Recommended that a loose pulley be installed and that a lock be provided to prevent the use of the machine by unauthorized persons.

Case 52.—Scrap man wandered from his proper place and attempted to get on board a larry car. In doing so he started the car and was caught and crushed. Fatal. Recommended that car be so inclosed that men can not get on the car without being seen by operator.

Case 53.—Top filler riding up in cage attempted to stop cage at about 50 feet. To do this, he reached through the structural work and grasped the operating cable which is placed in opposite hoistway. He pulled cable in the wrong direction, causing speed of cage to increase suddenly, and was dragged from cage and fell 50 feet. Fatal. Recommended to remove operating cable to a position in which it can not be reached from the other cage. Also to inclose cages to the height of 7 feet.

Case 54.—Laborer passing cold saw was struck by the belt when it broke. Fatal. Recommended that the belt guard be extended so as entirely to cover the belt.

Case 55.—Take-off at shear bed was caught under falling load of angles. The load was not evenly balanced, and the end which hung down struck the side of the car and the angles skidded from the chain, striking the man. Fatal. The foreman did not exercise good judgment in choosing the apparatus used in this operation.

Case 56.—Casting man was opening valve on ladle to make a pour. Metal splashed over top of ladle. Fatal. Recommended (1) that a canopy be erected over the pouring platform, which would catch the metal in such a case. (2) That the height of ladles be not increased without a corresponding adjustment of the trunnions. In this case 6 inches had been added.

Case 57.—Laborer overcome by fumes when rescuing fellow worker in benzol house. Fell on stairs, causing fracture of neck. Fatal. Recommended that means be provided to remove fumes when it is necessary to open faucets to drain water from storage tanks. Also that a door be cut through, so that escape from the space will be easier.

Case 58.—Crane hooker, for unknown reason, went up ladder to crane runway and was caught between crane girder and column. Fatal. Recommended that a warning sign be placed at foot of ladder warning all workmen not to go upon the runway without the permission of the crane foreman.

Case 59.—Laborer was at work in a car from which unloading was going on by means of a clam. A switching crew bumped into this car, and the man was caught between clam and end of car. Fatal. Recommended that a derailer be installed, so that cars can not be shunted down into this track.

Case 60.—Laborer stepped out of shanty onto a track on which a car was running out of control. The men on the car and others shouted to the man, but he could not hear on account of noise due to blast-furnace stoves blowing off. Fatal. Recommended that the installation of mufflers on stoves to reduce noise be hastened.

Case 61.—Fireman in boiler house caught when water tube burst. Fatal. Recommended that new type of fire doors be installed.

Case 62.—Weighmaster caught under plates falling from a pile. Some small plates had been piled on top of larger ones. Fatal. Recommended that in piling plates those of the same size be placed together. Also that the covering of the shipping area with a roof be considered. The icy condition of the plates may have been a factor in their falling.

Case 63.—Chipper attempted to cross tracks just in front of engine and was struck. Fatal. Recommended that a subway be provided, since there is a large amount of necessary passing.

Case 64.—Boiler maker's helper struck by metal splashing from ladle when it struck mold which he was repairing. Fatal. Recommended that molds be removed to some safe place for repair.

Case 65.—Laborer entered boiler which was to be cleaned and was overcome by gas. Fatal. The foreman should have stayed with his men and seen that the required procedure in cleaning the boiler was observed.

Case 66.—Repair man caught when a car operated by a cable into a dumping pit started down the incline. The wheels had been imperfectly blocked, and the jar due to removing rivets probably threw blocks out of place. Fatal. Proper clamps for use in such conditions had been provided, but the foreman in charge had not been informed regarding them.

Case 67.—Laborer returning from emergency hospital along railway tracks was run down. Fatal. Recommended that men having slight injuries be furnished street car tickets and sent to another hospital, which will not require walking on tracks.

Case 68.—Brakeman riding on car pushed by engine was caught against coal box of dinkey engine when the car on which he was riding was derailed due to accumulation of cinder and dirt. Recommended that track be kept clean, so as to avoid danger of derailment.

Case 69.—Stopper setter helping to pour heat in Bessemer. The molds as poured were capped with a cap weighing about 230 pounds. As the third mold was being poured the second exploded, forcing up the cap and spraying the entire vicinity with molten metal. Fatal. Recommended that the type of mold used at the time of accident be discarded and a safer type substituted.

Case 70.—Mold capper. See Case 69. Fatal.

Case 71.—Mold capper. See Case 69. Fatal.

Case 72.—Lever man working on pulpit 15 feet from mold. Case 69. Fatal. Recommended that a pulpit be erected inclosed with steel and wire glass.

Case 73.—Lever man. See Case 72. Permanent total disability.

Case 74.—Conductor went between engine and car to adjust coupler. Caught between drawheads. Fatal. Recommended that a coupling adjuster be applied.

Case 75.—Fireman of steam shovel struck by brake band falling from shelf in cab. The shelf was about 6 feet from floor. The brake band weighed about 50 pounds. Pneumonia developed. Fatal. Recommended that storage of spare parts in such a situation be discontinued.

Case 76.—Helper was assisting in enlarging tapping hole at blast furnace. Metal finally came out suddenly and struck some pipe scrap placed in the runner. The metal exploded. Fatal. Recommended that the placing of pipe scrap in the runner be discontinued.

Case 77.—Laborer run down when cleaning up at crossover. Fatal. The train crew did not have proper lookout when moving.

Case 78.—Helper struck by rod attached to heavy cable, when it fell from bustle pipe. This cable had been pushed aside to allow crane to pass. When crane moved the cable became entangled in the trolley and was pulled down. Fatal. Recommended that clamps be placed on crane runway, which will prevent crane from passing cable which operates cinder gate. When necessary for crane to pass this point millwright shall remove clamps and supervise the operations until clamps are replaced.

Case 79.—Hooker caught by falling ingot mold. The crane had set the mold down and the man had unhooked the chain. He stooped for some purpose and the mold toppled over on him. Fatal. Recommended that foreman should maintain better conditions in the yard and supervise operations more closely.

Case 80.—Pipe fitter's helper, using elevator as a platform in disconnecting a steam pipe, was caught between railing at back of elevator and floor of open hearth. Just how elevator was started is not known, as man was alone at time. Fatal. Recommended that the railing at back be extended to 7 feet in height.

Case 81.—Laborer cleaning track run down by engine. Fatal. Train crew were not keeping proper lookout.

Case 82.—Hook-on caught when charging box full of bloom ends struck a bridge girder and was thrown from the car. Hook-on was riding the car and was thrown off with the box. Fatal. Recommended that clearance be increased at this point.

Case 83.—Laborer fell through temporary covering of pit, in which there was about 6 inches of hot water. Fatal. Recommended that the opening into the treating tank be railed securely.

Case 84.—Boiler maker fell from blast-furnace stove 100 feet to the ground. When he loosened one bolt the spring of a channel caused another to break. Foreman should have required use of life belt.

Case 85.—Track cleaner was attempting to loosen defective brake, so as to be able to move the car. As he worked on the brake in front of the wheels, cars were shunted down the track and bumped the one on which he was working. Fatal. Recommended (1) that steps be taken to have defective brakes repaired more promptly; (2) that some signal system be adopted which will warn men when cars are to be shunted into this track.

Case 86.—Laborer struck when hose blew off from oxygen tank. Fatal. Recommended that a more secure type of coupling be installed on the oxygen tanks.

Case 87.—Laborer was moving car at pig machine with pinch bar. As he worked, another car was bumped into it by an engine coming to couple on. Fatal. Recommended that a derailer be installed at the top of the grade and that train crew send some one ahead when coming down.

Case 88.—Laborer run down by dinkey engine at point where clearance was inadequate. Fatal. Recommended (1) increased clearance; (2) better lighting; (3) change in engine cab, so as to give engineer better view.

Case 89.—Laborer knocked from coal barge into river by cable used to move barges into position for being unloaded. Fatal. Recommended that it be made the rule that operator before starting cable shall look to see that men on the barges are in the clear. The place is well lighted, so that the operator can easily see where the men are.

Case 90.—Pit laborer in Bessemer struck by scrap falling from the roof 25 feet above. This scrap accumulates rapidly at times from the blow of the converter. It is removed as promptly as possible, but sometimes becomes clinched under the iron plates forming the roof and can not be got off without shutting down the mill. In this case the jar of the scrap buggy overhead caused a portion to be loosened and fall. Fatal. Recommended that an angle be attached to roof edge, which will tend to keep loosened pieces from falling.

Case 91.—Pipe fitter's helper was removing brick for installation of steam pipe in gas main. Starting to go out the man took the wrong direction and fell into a downtake 12 feet deep, in which was a quantity of hot soot. Fatal. Recommended that gates be installed in mains to prevent men working in them from reaching the downtakes by mistake.

Case 92.—Laborer ran across railway track in front of a train coming on the other track just in time to be struck by engine. Fatal. Recommended that watchman be stationed at this point to direct men to use a footbridge, which is provided over the tracks.

Case 93.—Rigger and four fellow workers were removing bolts holding platform on which they stood, the other side being fastened to girder of building. When the bolts were partly removed the platform canted, throwing man off to the floor, 25 feet below. Fatal. Recommended that foreman be instructed to stay such platforms by use of block and fall when it is necessary to remove bolts. Also that a knee brace be placed under each platform.

Case 94.—Rigger fell into furnace, 100 feet, when chain block broke. Fatal. Recommended (1) that 4-ton, instead of 2-ton, blocks be used, and (2) that the cross arms of new blocks be steel forging instead of cast steel.

Case 95.—Boring mill hand used wrench to loosen tool which he took out for grinding. When he put the tool back he did not remove the wrench, and when the machine was started, the wrench was carried around by the platform and he was caught between it and the upright. Fatal. Recommended (1) that a rack be provided alongside the machine for tools; (2) change the position of the starting lever so that a man will face machine when starting up.

Case 96.—Repair man asphyxiated when he went into a pit to find a bell valve which had fallen from its proper place. Fatal. Recommended that this bell valve be more securely fastened in place.

Case 97.—Laborer injured when heater exploded. A boiler was blown off into this heater, giving rise to an undue pressure. Fatal. Recommended that arrangements be made to blow off into air or into sewer.

Case 98.—Laborer crossing track between two cars was caught between bumpers. Fatal. Recommended that when cars are moved in the mill a member of train crew go ahead to see that men are in the clear.

Case 99.—Lineman came in contact with 6,000-volt power line. Fatal. Recommended that, if possible, greater clearance be established.

Case 100.—Laborer run down by engine. Fatal. This crossing will always be very dangerous as long as the railway has tracks in addition to the mill tracks. The railway tracks should be removed.

Case 101.—Craneman sitting on track was struck when buggy came up the mill. Recommended that fenders be placed on this car and that a warning signal be installed.

Case 102.—Wireman and helper drilling holes to fasten electric conduit to wall. Were using board to pry drill up to its work. Board broke and helper fell. Fatal. Recommended that a stronger piece of timber be used as a pry in such cases.

Case 103.—Repair man sharpening chisel on emery wheel when it burst. Fatal. Recommended that this and all other similar wheels be equipped with the standard safety hood.

Case 104.—Steel pourer was caught when on opening the stopper a quantity of steel jumped over the ladle top. Fatal. Recommended that canopies be installed over all pouring platforms in open hearths.

Case 105.—Laborer sitting on larry car track was caught by car. Fatal. The guard provided was in bad order. Directed that when guards become ineffective machines be stopped until repairs are made.

Case 106.—Man was holding sledge for fellow worker to strike with another sledge in removing wheel from shaft. A chip flew, striking abdomen. Fatal. Recommended that hereafter hydraulic pushers be used exclusively in removing wheels from shafts. The use of sledges is to be discontinued entirely.

Case 107.—Wireman's helper came in contact with high-tension wires and fell from tower about 42 feet. Fatal. Recommended that distance between high-tension wires be increased and that where they enter the mills they be inclosed in conduits.

Case 108.—Drier man's clothes were set on fire by back fire in drier which burst out at the cleaning door where he was working. Fatal. Recommended that a half-inch steam line be led into the drier at this point which, when opened, will force the dust out without danger of back-firing. A platform will also be installed to improve the working conditions.

Case 109.—Man fell down 26 feet inside of pipe at condensers being erected. Fatal. Recommended that men doing this kind of work be required to wear a life belt.

Case 110.—Foundry rammer was caught under a core barrel which was overset when the craneman began to hoist another barrel whose flange was caught under that of the overset barrel. Fatal. Recommended that greater care be exercised in storing these barrels that the flanges do not overlap, and that the light in this part of the foundry be improved.

Case 111.—Oiler received shock from motor which he was oiling. Due to defective insulation the motor frame had become electrified. Fatal. Recommended that the frames of such motors be grounded.

Case 112.—Cinder dump man was caught by hot cinder when an explosion caused ladle to overturn. Fatal. Recommendations: (1) Make center pin longer and provide for a cotter pin through the end. This will prevent ladle from leaving truck. (2) Place a rail clamp on each end of cinder truck, such as is in use on locomotive crane.

Case 113.—Ore bin laborer fell through a space about 3 feet wide between trestle platform and girder carrying track rail. Cause of fall unknown. Suffocated in ore. Fatal. Recommended that this opening be closed with a grating of about a 10-inch opening.

Case 114.—Laborer shoveling out dirt from dumping car when bottom closed up catching man. Fatal. Found that the cylinders for closing the bottom were not in good order. Ordered that they be put in proper order.

Case 115.—Millwright caught by explosion of coal dust at bin in open hearth. Fatal. Recommended that the slide feed for coal dust be replaced by a dust-proof screw feed.

Case 116.—Millwright's helper. See Case 115. Fatal.

Case 117.—Boiler maker foreman caught by platform which swung around when locomotive crane pulled and hoisted on it. Platform and steps were being removed. Recommended that in work of this kind two hitches be made to material instead of one.

Case 118.—Laborer shoveling coal into chute under car when car door dropped down, crushing him against rail. Fatal. Recommended that in such unloading of coal the foreman shall remain in direct charge of the work until it is completed. Also that the coaling station be removed to some locality not on main track which will permit unloading without haste.

Case 119.—Laborer. See Case 118. Fatal.

Case 120.—Laborer. See Case 118. Fatal.

Case 121.—Laborer caught between peel of charging car and charging buggy when controller of charging car stuck and operator was unable to control car. Fatal. Recommended that charging cars be pushed entirely clear of furnace before attempting to do work of this kind.

Case 122.—Laborer passing between two cars when engine bumped them. Fatal. Recommended (1) that cars be not left with space between them into which men can go. (2) That a derailer be placed at the entrance of this mill.

Case 123.—Pipe fitter's helper burned when torch exploded and threw burning oil over clothes. Fatal. Recommended (1) that electric extension lights be used for such work whenever possible. (2) That three small holes be made in the cap of each torch so that pressure inside may be relieved without explosion.

Case 124.—Laborer caught between magnet and side of car from which he was unloading scrap. The rails were wet and the crane trolley slipped causing magnet to swing. Recommended that men be instructed to stand outside of car when directing cranemen in using magnet for unloading.

Case 125.—Track laborer fell onto track and was run over by engine. Fatal. Recommended that lighting in tunnel where accident occurred be improved so that engineers can see more clearly the men who are obliged to work there.

Case 126.—Brakeman in getting off footboard of engine caught raincoat on bolt causing him to fall, striking his head. Fatal. Recommended that as rapidly as possible the passenger type of platform be installed on all locomotives.

Case 127.—Laborer caught between pieces of scrap steel in furnace being repaired. The pieces weighed about 6,000 pounds each. One had been moved to the side of the furnace. When man began to shovel out loose brick the other piece toppled over. Fatal. Recommended that such pieces of scrap be entirely removed from furnaces undergoing repair.

Case 128.—Laborer caught by explosion in dryer of coal pulverizer in open hearth. Fatal. Recommended: (1) That dust-proof screw feed take the place of mechanical slide feed. (2) That bin be cut off when repairs are in progress. (3) Inspection of bin to see that it is empty before repairs begin. (4) Installation of recording thermometer to show when temperature is running dangerously high.

Case 129.—Man was replacing lamp above coal conveyor. Stepped into opening where plate had been removed in order to observe when coal was entirely out of conveyor. Loss of leg. Directed that plate be not removed until conveyor has been operating one half hour. This gives time for complete emptying and plate can be immediately replaced. Use of powdered coal will be shortly abandoned at this plant, removing several hazards.

Case 130.—Laborer whose duty it was to replenish oil in cans on the gallery of foundry apparently stepped onto runway while looking for a can. In some way he came in contact with power rail and fell across the runway. In this position a crane which was down for repair was pushed by another crane onto the man. Whether the shock or the crushing injury was the cause of death could not be determined. Fatal. Recommended that cranes down for repairs shall not be pushed about by other cranes. This may be made impossible by chaining the idle crane in place.

Case 131.—Chipper caught under falling load of billets when link of chain broke. Fatal. Links of chain had evidently been affected by acid used in pickling billets before chipping. In some of them the cross section had been reduced from $1\frac{1}{8}$ to $\frac{5}{8}$ inch. Recommended that billets be placed in the pickling vats when empty and thus avoid exposing chains to action of acid.

Case 132.—Laborer caught between grab bucket and side of car when unloading. Fatal. Recommended that cranemen do not operate grab bucket in car while man is inside car.

Case 133.—Patrolmen brought motor boat into boathouse during a storm at night. They closed windows and the door to protect themselves from the storm. The engine continued to run and the fumes from exhaust caused asphyxia. Fatal. Recommended that in motor-boat houses and garages where it may be desirable to keep engines running provision be made for piping the exhaust into the open air.

Case 134.—See Case 133. Fatal.

Cases in which Care on the Part of the Injured or His Fellow Worker is the Only Remedy.

Case 1.—Crane hooker adjusting chain on lift of billets. On his signal to lower the craneman hoisted. Cable broke and block and hooks fell, striking man on thigh. Amputation of leg necessary. Craneman at fault.

Case 2.—Cooling tank for crane tongs overset when craneman started crane without raising tongs. Laborer seated near tank was caught and held by the foot and the hot water poured over him. Fatal. Craneman at fault. No safeguard possible.

Case 3.—Electrician pulled disconnecting switch of wrong engine and was burned by the flash. Fatal. Man familiar with conditions and should not have made the mistake.

Case 4.—Roll hand undertook during a delay in rolling to grind a pass in the rolls which had become roughened. When rails began to move he was caught and legs crushed. Fatal. Man should have gotten away sooner.

Case 5.—Carpenter climbing ladder carrying scantling. Fell 36 feet. Fatal. Ropes are provided for pulling up material. Man should have used this provision.

Case 6.—Carpenter removing tiles from roof of building stepped on tile at an unsupported point. The tile gave way and the man fell 50 feet. Fatal. Man aware of danger of stepping on tile where not supported.

Case 7.—Lamp trimmer was hanging lamps from the vicinity of crane runway. Did not see approaching crane and hand was caught. Amputation necessary. Craneman at fault.

Case 8.—Machinist's helper, after inspecting crane trolley according to directions of foreman, came down from trolley platform to the top of cab. There he lay down and crawled between cage and beam of crane. He then ordered craneman to rack out and was caught by trolley. Fatal. No remedy except greater care on part of men.

Case 9.—Crane-repairman left crane at platform to repair switch. Craneman then proceeded to transfer materials with magnet. The repair man, after finishing his job, must have gotten on the crane, crossed to other side, and there, in trying to get off, was caught and crushed. Fatal. The repair man should have notified the craneman that he needed to cross.

Case 10.—Oiler fell from ore bridge to bottom of ore bin—90 feet. Fatal. Was supposed to be oiling on another bridge at some distance from this. Reason, if any, for being on this bridge unknown. The point from which, apparently, man must have fallen is well guarded by railing and toeboard. Nothing in the way of prevention except on the part of the men can be suggested in such cases.

Case 11.—Loader was caught between lift of billets and side of car when craneman racked in. Fatal. Loader was adjusting the side blocks, which had fallen down. Craneman regarded as negligent and discharged.

Case 12.—Extra craneman left the crane and then attempted to return without signaling to stop. He stepped on the end truck and, slipping off onto the walk, was crushed between girder and column. Fatal. Man negligent, but craneman somewhat at fault.

Case 13.—Man struck by engine when walking through subway. Fatal. Engine crew claimed that smoke obscured view as they backed out of mill. Should have waited for smoke to clear.

Case 14.—Car blocker run down by cars which railroad crew were moving. Fatal. Crew at fault in not notifying foreman of coal hopper according to rule.

Case 15.—Chipper struck by block falling from crane. Fatal. Craneman pulled main switch of crane just as hoist block was about to strike limit switch. This killed the limit and block went up until cables broke and block fell.

Case 16.—Painter fell from plank which he had placed on a temporary safety barricade. He fell from roof to scaffold two floors below. Fatal. Partner warned him of the insecurity of the arrangement which he made. Man clearly took a chance rather than do the work necessary to safety.

Case 17.—Gas washer went into fan house to pack leaky bearing and was asphyxiated. Fatal. It was not his duty to attend to this work, and a rule requires men not to go alone into places where gas is likely to accumulate. Methods of keeping inclosed spaces clear of gas deserve further attention.

Case 18.—Laborer going home from work was run down by train. Thought that he was under the influence of liquor and tried to board moving train. Fatal. No safeguard except care on part of man.

Case 19.—Laborer run down by a string of cinder pots being pushed out of open hearth pit. He was standing on the track with his back to the approaching train warming himself from molds which stood on an adjacent track. The train was moving very slowly, and when someone noticed the man's danger and signaled the engineer he stopped at once, but when the slack of the coupling straightened out it was enough to strike the man and knock him down. Fatal. Only care can prevent such occurrences.

Case 20.—Craneman left his crane, and for some unknown reason went upon the crane runway and was caught between the end carriage of another crane and a column of the building. No duty required or even suggested his being at the point where he was injured. Fatal. Care is the only remedy.

Case 21.—Unloader operator started motor and left his cab to readjust part of machine, using a bar for this purpose in the vicinity of some open gears. When the part he was adjusting came into place the sudden movement of the bar threw him into the gears. Fatal. Man had been warned not to leave the cab and leave the motor running. The adjustment he tried to make was another man's duty. Covers were in process of construction for the gears.

Case 22.—Switchman went between cars to couple. Caught and crushed. Fatal. Care is the only possible safeguard.

Case 23.—Coal elevator operator removed cover of manhole and went down into coal bunker. There his head was caught between conveyor buckets and bracket. Fatal. No duties requiring man to enter the bunker. Rules forbid doing repairs or approaching machinery when it is in motion.

Case 24.—Welder struck head against hydrogen tank, making slight wound. When he reported to hospital several days later the wound was infected. It seemed to yield to treatment but later changed for the worse and he finally developed a case of meningitis. Fatal. Prompt report of even slight injury is the only safeguard.

Case 25.—Laborer working with others on scaffold in furnace removing old lining preparatory to relining. Around the scaffold is a space of about 12 inches through which the bricks may fall to the bottom of the furnace. Through this space the man fell. Fatal. There seems to be no way to conduct this operation in a safer manner. Care on the part of workers is the only safeguard.

Case 26.—Car inspector stepped between cars to allow engine to pass. A locomotive making up a train on the track on which he was standing bumped the cars, knocking him down, and the wheels passed over him. Fatal. Care on part of man only safeguard.

Case 27.—Larry car learner was on platform alongside hopper of larry car at coke ovens. Man is not supposed to remain on this platform when car is in motion, since the clearance at various points is not sufficient to pass safely. He was caught and crushed at such a point. Fatal. The regular operator warned him to get down into cage. Only care on men's part will avoid such occurrences.

Case 28.—Crane hooker had lain down to sleep behind a pile of steel. Craneman, moving castings, in some way shut power off and casting fell on hooker. Fatal. Hooker to blame, since he had no right to use the place which he did for taking a nap. The craneman can not be blamed, since he could not see man in position he occupied.

Case 29.—Tool repair man stood on track watching locomotive on another track and failed to notice one on track where he was standing. Knocked down and crushed. Fatal. There are no curves at this point and the only available safeguard is attention on the part of those having to cross the yard.

Case 30.—Boiler maker adjusting a channel with crane when knot of rope slipped, allowing channel to fall. It weighed about 1,400 pounds. Fatal. The man had himself made an improper knot in adjusting the rope.

Case 31.—Laborer run down by train. Loss of leg. Man was getting out of mill somewhat before quitting time by an improper route. The train crew did all possible to save him.

Case 32.—Laborer helping to move car along track was caught by swinging magnet of crane. Fatal. Craneman disregarded rules in moving the magnet.

Case 33.—Laborer crossing track run down by engine. Fatal. Train crew taking all possible precautions. Man took chance in crossing ahead of engine. Should have waited for it to pass.

Case 34.—Switchman forgot to throw switch directing cars on proper track. As a result they came back on the track from which they had just been pulled. He was walking on this track with his back to the cars, evidently expecting them to take the track for which he had not thrown the switch. The engineer could not see the man in this position. Fatal. The man only could prevent such accidents.

Case 35.—Yard cleaner run down by ladle train. Fatal. Train crew were following usual procedure. It would seem to be a case where only care on man's part could prevent accident.

Case 36.—Fireman scalded when a head-on collision occurred between his train and another. Fatal. Flagman did not go back proper distance and give signal.

Case 37.—Conductor closing switch walked onto adjacent track and was struck by another train. Fatal. Man of long experience and should have been properly cautious.

Case 38.—Laborer washing at a drain where the clearance was insufficient was struck when train pushed in. Fatal. There is a shanty not far from this place provided with basins and other conveniences, so there was no occasion to use this dangerous place. Man must be held responsible.

Case 39.—Laborer struck by slide bar when crane lowered lift of rails. In piling 100-pound rails, 16-pound rails about 15 feet long are used to separate the successive layers. One of these was allowed to project about 24 inches. The load struck this projecting end, causing the light rail to swing around violently. Fatal. Men instructed to place slide bars so that they will not project.

Case 40.—Engineer caught between tender and locomotive when his engine collided with another. Fatal. Man did not have his train under proper control on a down grade.

Case 41.—Track laborer run down by train. Fatal. Train crews must be educated to take greater precautions in moving through yards.

Case 42.—Watchman on bridge struck by engine. Fatal. Train crew should use greater care in keeping effective lookout.

Case 43.—Laborer run down by engine. Fatal. Train crew not sufficiently on the lookout.

Case 44.—Laborer caught under slab falling from magnet. Fatal. Men had been cautioned not to get too near when manipulating objects on magnet since power is likely to go off without warning.

Case 45.—Brakeman stepped between cars on short side of curve to adjust coupling and was caught. Fatal. Man did not observe rules.

Case 46.—Piler caught between lift of plates and pile when craneman pulled wrong lever, racking out trolley instead of lowering. Fatal. Craneman entirely at fault.

Case 47.—Craneman raised his lift until the limit switch was brought into action. He got on the crane to locate the trouble and fell to the plate which was being carried. Fatal. The man had been directed by motor inspector to remain on platform of crane until trouble was located. This he did not do. The action of the limit switch in this case doubtless prevented the blocks from going so high as to break the cables. If this had happened several men on the floor below would have been endangered.

Case 48.—Laborer caught under falling lift of plates when crane dog came off. Fatal. Care on man's part not to get under loads would seem the only remedy.

Case 49.—Blacksmith's helper struck in abdomen when end of bar he was turning on anvil slipped from anvil. Fatal. Greater care on part of man only possible preventive.

Cases Involving Unavoidable Trade Risk.

Case 1.—Carpenter helping to remove scaffold from furnace after relining. A piece of scantling slipped from a bundle which had been hoisted to the top of furnace. It fell back inside the furnace striking the man on the head as he came back onto the scaffold. No recommendation.

Case 2.—Laborer passing under boiler floor was struck on the head by a brick falling from floor above—about 24 feet. No recommendation.

Case 3.—Labor foreman in charge of gang of laborers was engaged in taking down from a coal stock pile a section of railroad track. The pile was about 10 feet high. It did not appear that the track was dangerously undermined until it gave away and as it slid down the man was crushed between the rails. The committee makes no recommendation.

Case 4.—Laborer fell from walk into ore bin and was smothered. No recommendation.

Case 5.—Regular engineer had got out of cab to assist the switchman. The deceased offered to run the engine. On getting into cab he apparently lost control of engine and ran into platform and was crushed. No recommendation.

Case 6.—Lineman fell from tower, probably due to contact with live wires. He and fellow worker had been engaged on dead circuits on tower. He was going to secure material when it is supposed he came in contact with the live wire. No recommendation.

Case 7.—Fell from gondola car on which he was standing when locomotive crane kicked another car against it. No recommendation.

Case 8.—Machinist's helper came in contact with overhead trolley bars and was electrocuted. Man climbed up to the vicinity of the bars without direction from the machinist and for no apparent reason. May have misunderstood his directions. No recommendation.

Case 9.—Laborer pushing truck on which were loaded ingot mold flasks. The flasks were to be transferred by crane from the door of shop. The truck got out of control and ran past the point where the crane was waiting. The crane hooks caught on the flasks causing them to fall. The man was crushed. No recommendation.

Case 10.—Hammerman forging steel billet on 2,000-pound steam hammer. Was cutting billet. Cutter had stuck and man was using set on top of it. When hammer came down the set twisted, throwing handle against man with so much force as to puncture his liver. Fatal. No recommendation.

Case 11.—Brakeman standing on end sills of car was probably thrown off by jar of starting. The wheels passed over his body. Fatal, No recommendation.

Case 12.—Brakeman fell from car and wheels passed over body. Fatal. No recommendation.

Case 13.—Charger placing billet in heating furnace when end swung around striking him in abdomen. Fatal. No recommendation.

Case 14.—Rigger was thrown into top of furnace when chain block broke. He fell 120 feet. Fatal. No recommendation.

Case 15.—Laborer engaged in tearing down open hearth furnace overcome by heat. Had been working a spell of not more than 15 minutes. Fatal. No recommendation.

Case 16.—Conductor thrown from car when engineer applied brakes suddenly thinking he was likely to run down a water boy. Fatal. No recommendation.

Case 17.—Fireman suffered heat stroke. Fatal. No recommendation.

Case 18.—Craneman was crossing the bridge over the coupling box when the same broke and a piece flew up striking him. Fatal. No recommendation. The coupling casting had a flaw which could not be detected externally.

Case 19.—Man riding ore car on trestle to set brake and stop car at desired point. It would seem that the sill of the car where he was standing was slippery and that the jar of the car threw him off. Fatal. No recommendation.

Case 20.—Man riding on footboard of dinkey coal box was thrown from same when car pushed by dinkey was derailed. Loss of leg. No recommendation.

Case 21.—Cinder pit man fell from ladle cars when going out of pit. Fatal. No recommendation. Not known just how accident happened.

Case 22.—Laborer caught when gun carriage fell from crane due to breakage of chain. Fatal. No recommendation. No flaw in chain, which was of a size which should be ample to sustain weight.

Case 23.—Brakeman fell from footboard of engine and was dragged for some distance. Fatal. No recommendation.

Case 24.—Inspector had his clothes set on fire by the explosion of a torch. Fatal. No recommendation. Experiment with new type of searchlight. Tests did not indicate the cause of torch explosion. It does not seem to be possible to detect flaws in the steel except by the use of the torch.

CHAPTER IX.—THE ACCIDENT RECORD TO 1919.[14]

The current chapter will attempt to present as complete a record of the accident experience of the iron and steel industry up to the end of the year 1919 as the available data will permit.

In each of the following tables the year 1907 is introduced whenever possible since it represents the conditions which prevailed prior to the beginning of the organized safety movement. The figures presented do not fully indicate the unsatisfactory situation of that period. The keeping of usable records accompanied the giving of more attention to preventive measures and consequently the plants and companies data for which it was possible to utilize are not an average but represent the best conditions then existing.

THE INDUSTRY.

Table 65 and Charts 15, 16, and 17 show conditions in the industry as a whole.

TABLE 65.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE IRON AND STEEL INDUSTRY, 1907 TO 1920, BY YEARS AND PERIODS.

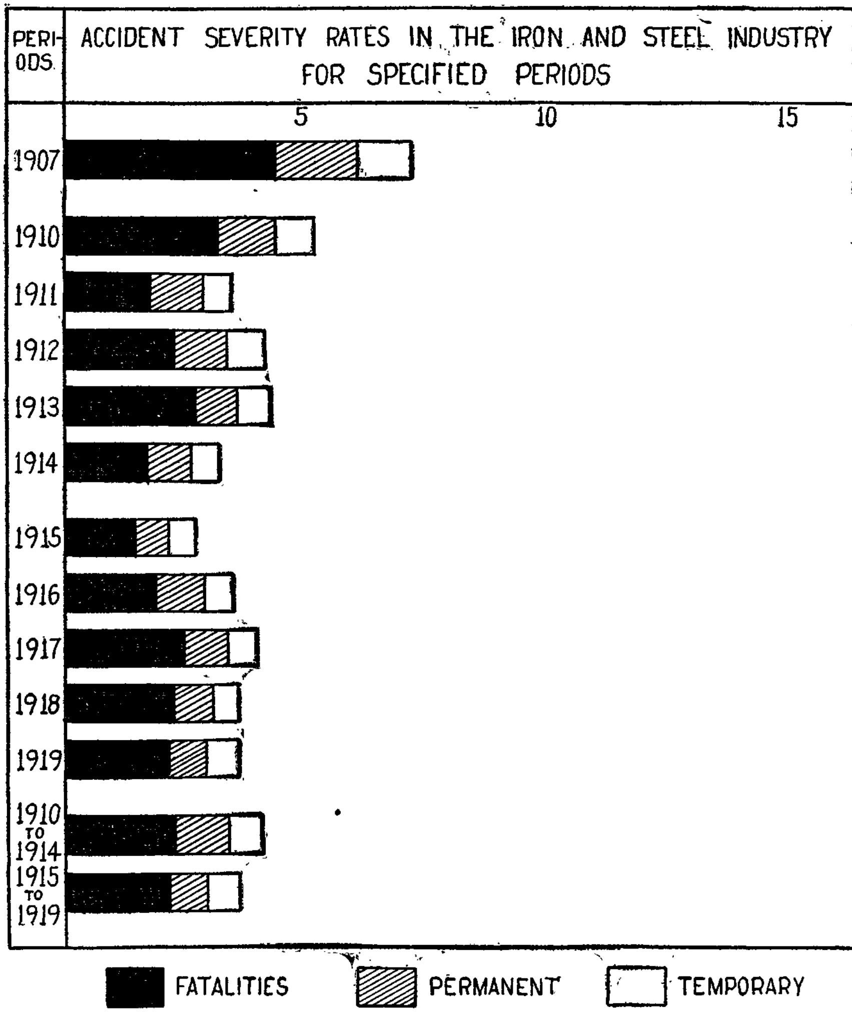
Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	27,632	61	106	6,530	6,697	0.7	1.3	78.8	80.8	4.4	1.7	1.1	7.2
1910	202,157	327	848	44,108	45,283	.5	1.4	72.7	74.7	3.2	1.2	.8	5.2
1911	231,544	204	931	34,676	35,811	.3	1.3	49.9	51.5	1.8	1.1	.6	3.5
1912	300,992	348	1,241	54,575	56,164	.4	1.4	60.4	62.2	2.3	1.1	.8	4.2
1913	319,919	426	1,200	55,556	57,182	.4	1.3	57.9	59.6	2.7	.9	.7	4.3
1914	256,299	219	860	37,390	38,469	.3	1.1	48.6	50.0	1.7	.9	.6	3.2
1915	116,224	87	372	13,481	13,940	.2	1.1	38.7	40.0	1.5	.7	.5	2.7
1916	166,646	159	728	20,655	21,542	.3	1.4	41.3	43.0	1.9	1.0	.6	3.5
1917	410,852	523	1,268	57,094	58,885	.4	1.0	46.3	47.7	2.5	.9	.6	4.0
1918	474,435	543	1,253	54,293	56,089	.4	.9	38.1	39.4	2.3	.8	.5	3.6
1919	377,549	419	848	41,009	42,276	.4	1.0	40.2	41.6	2.2	.8	.6	3.6
1920	442,685	327	1,084	49,482	50,893	.2	.8	37.3	38.3	1.5	.8	.4	2.7
1910 to 1914	1,310,911	1,524	5,080	226,305	232,954	.4	1.3	57.5	59.2	2.3	1.1	.7	4.1
1915 to 1919	1,545,706	1,731	4,469	186,532	192,732	.4	1.0	40.2	41.6	2.2	.8	.6	3.6

The foregoing table and Charts 15, 16, and 17 have points of interest which will be found common in a greater or less degree to all the departments which are represented in it: (1) The year 1907 exceeds in every particular any later year. (2) There are points of high frequency and severity corresponding with the periods of industrial

[14] Rates are introduced for 1920 whenever available.

revival. It should be noted that it is the period of revival rather than the period of high productivity which shows the tendency to increasing rates. It will appear repeatedly in other connections that the necessary introduction of new men into the working force is the prime cause of this increase. The fluctuation chart brings out very

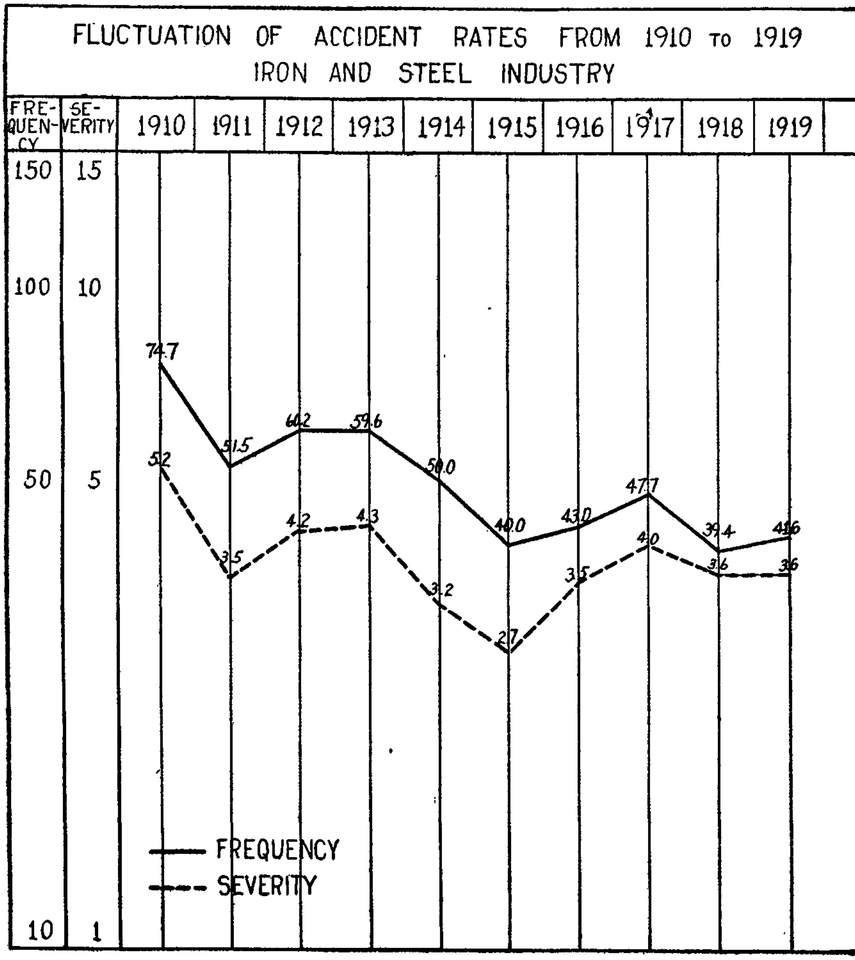
CHART 15.



clearly this relation of accident rates to the movement of industry. (3) The chart showing trend, in which overlapping five-year intervals are utilized, indicates two things: (*a*) There has been a steady and marked downward tendency during the entire period; (*b*) This tendency has been more marked in minor injury, which determines frequency, than in severe injury, reflected in the severity rates.

Attention should be called to the fact that in both the fluctuation and the trend charts in this chapter the position and relation of the frequency and severity curves are significant. (1) The higher the rates the farther up on the charts will the curves run. (2) Commonly the severity curve runs below the frequency. Approach to or passing above the frequency curve on the part of the severity curve indicates

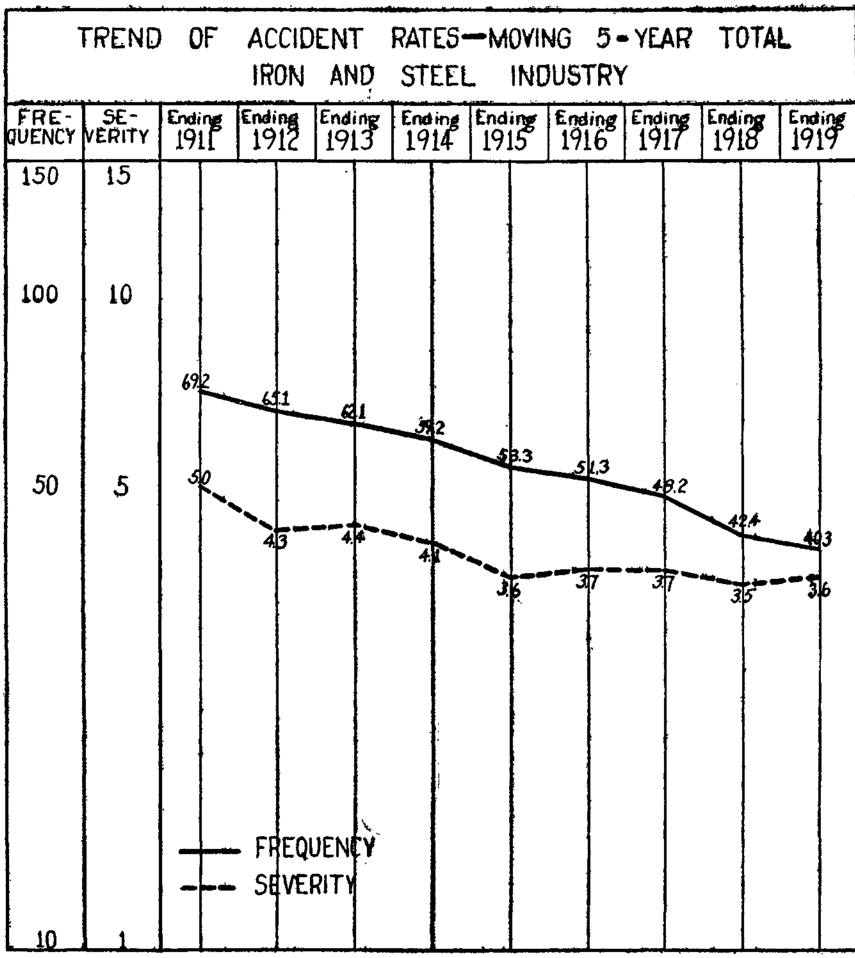
CHART 16.



a relatively higher severity. For example, in blast furnaces the severity curve lies entirely above the frequency curve, while in sheet mills the reverse condition obtains.

All the charts in this chapter are drawn on the same scale so that in a direct comparison the impression received through the eye gives a correct idea of the relationships of the departments involved.

CHART 17.


TREND OF ACCIDENT RATES—MOVING 5-YEAR TOTAL
IRON AND STEEL INDUSTRY
FRE-QUENCY
SE-VERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
15
100
10
50
5
10
1
69.2
65.1
62.1
59.2
53.3
51.3
48.2
42.4
40.3
5.0
4.3
4.4
4.1
3.6
3.7
3.7
3.5
3.6
FREQUENCY
SEVERITY

BLAST FURNACES.

Table 66 and Charts 18, 19, and 20 present the facts as to blast furnaces.

TABLE 66.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR BLAST FURNACES, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	1,566	9	11	456	476	1.9	2.3	97.1	101.3	11.5	2.7	1.8	16.0
1910	19,389	68	68	4,971	5,107	1.2	1.2	85.5	87.9	6.9	1.7	1.0	9.6
1911	21,479	52	54	3,303	3,409	.8	.8	51.3	52.9	4.8	.9	.8	6.5
1912	27,154	73	87	4,790	4,950	.9	1.1	58.8	60.8	5.4	1.0	.8	7.2
1913	31,988	86	80	4,749	4,945	.9	.8	58.1	59.8	5.3	1.0	.9	7.2
1914	26,572	45	77	3,935	4,057	.6	1.0	49.4	51.0	3.5	1.0	.7	5.2
1915	10,721	19	23	981	1,023	.6	.7	30.5	31.8	3.5	.6	.4	4.5
1916	14,965	23	57	1,763	1,843	.5	1.3	39.4	41.2	3.1	.9	.6	4.6
1917	36,282	79	93	4,440	4,612	.7	.9	40.9	42.5	4.4	.9	.5	5.8
1918	41,449	102	72	4,368	4,542	.8	.6	35.0	36.4	4.9	.8	.5	6.2
1919	32,889	94	67	3,745	3,906	1.0	.7	38.0	39.7	5.7	1.0	.5	7.2
1920	35,470	47	58	3,214	3,319	.4	.5	30.2	31.1	2.7	.9	.4	4.0
1910 to 1914	126,582	324	366	22,578	23,268	.9	1.0	60.4	62.3	5.2	1.0	.8	7.0
1915 to 1919	136,166	317	312	15,287	15,916	.8	.8	37.4	39.0	4.7	.9	.5	6.1

Inspection will immediately disclose that this department is one of relatively high hazard. The black portions of the bars in the severity chart, indicating as they do the relative seriousness of death in each of the several years, is an impressive indication that this department demands constant and energetic attention if it is to reach and maintain a satisfactory accident level. The second five-year period has a lower rate than the first, but each of the charts shows a disquieting tendency during the war period in the direction of increase which should be resisted with the utmost possible vigor.

Table 67 shows how the different occupational groups in the blast furnaces fared in the matter of injury.

In frequency both in the earlier and the later period the cast-house men had a most undesirable preeminence. In severity their rate in the earlier period (17.9 days per 1,000 hours' exposure) is higher than any other. Their situation improves in the second period to such an extent that their rate (6.9 days) is below that of the laborers (9.8 days) and of the unclassified workers (11.7 days).

An interesting light is shed upon the probable cause of this improvement by noting that of the rate of 6.9 days for cast-house men in the later period 5.8 days are due to burns, while laborers have but 1.8 days and the unclassified group 3 days. It is well known that in the course of development of the blast furnace, improvements in structure have been made which have materially lessened the chance of fatal injury through "breakouts" of hot metal. This improvement is reflected in the much lower severity rate of cast-house men in the second period.

TABLE 67.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR BLAST FURNACES, 1905 TO 1914 AND 1915 TO 1919, BY OCCUPATIONS.

Occupation.	Number of workers.		Frequency rates (per 1,000,000 hours' exposure).		Severity rates (per 1,000 hours' exposure).	
	1905–1914	1915–1919	1905–1914	1915–1919	1905–1914	1915–1919
Cast-house men	1,357	1,727	126.8	71.8	17.9	6.9
Common labor	4,930	6,273	83.5	39.3	8.9	9.8
Mechanics	3,670	4,670	42.7	28.7	6.4	6.0
Stockers	886	1,128	52.3	23.4	9.0	3.4
Unclassified	3,000	3,824	46.4	46.6	15.4	11.7
Total	13,849	17,621	66.9	40.3	10.6	8.53

CHART 18.

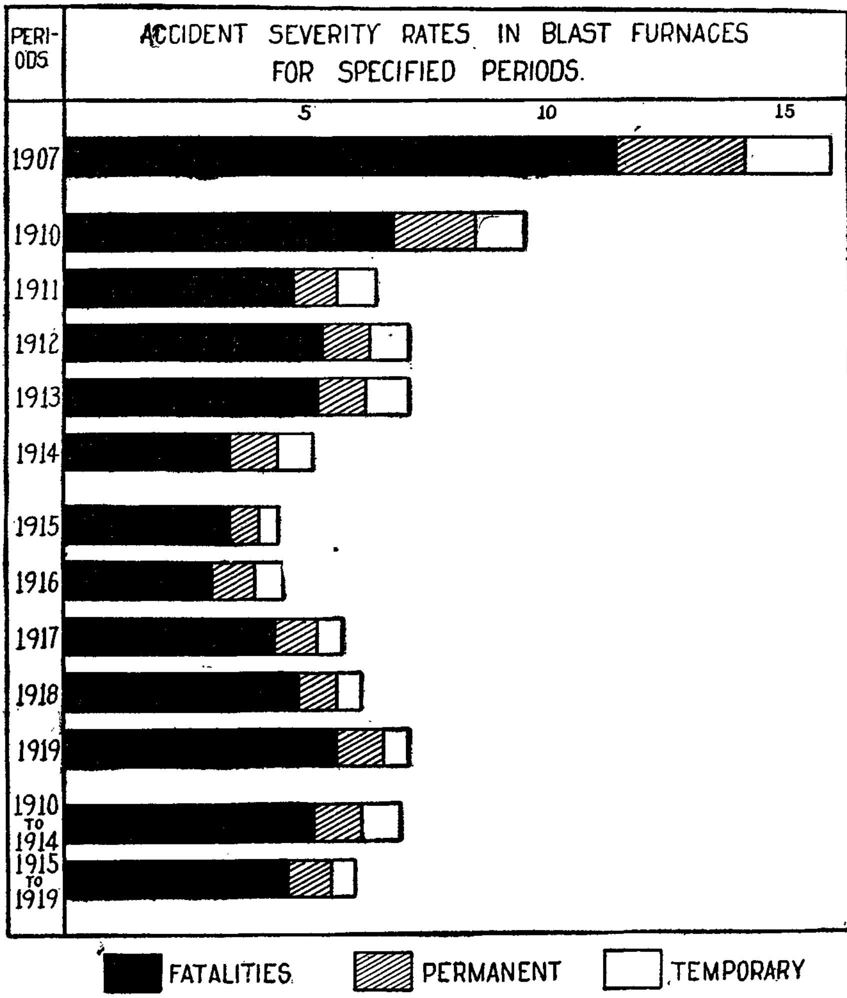


CHART 19.

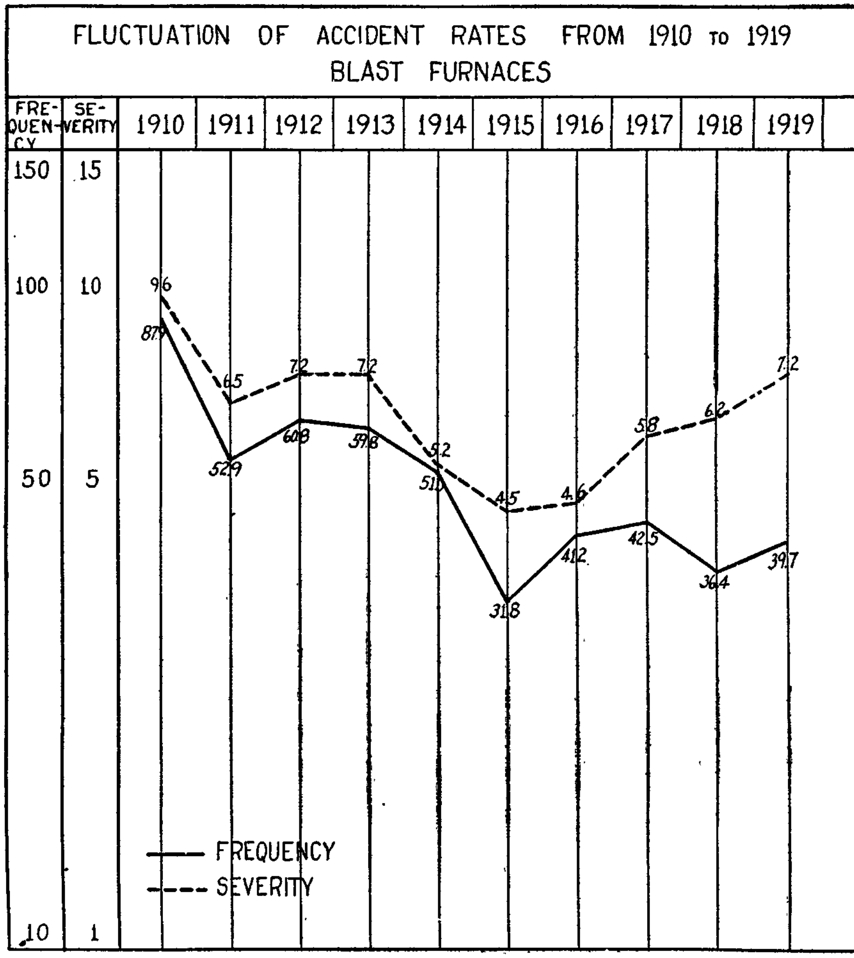
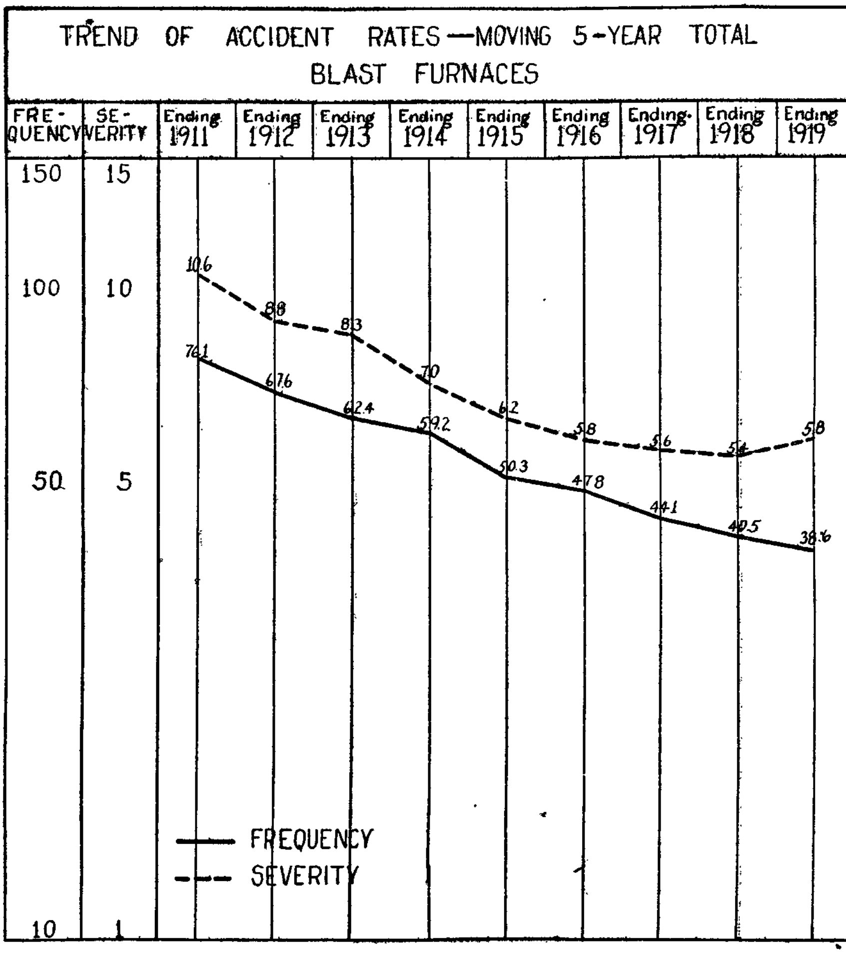

FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
BLAST FURNACES
FRE-QUEN-CY
SE-VERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
9.6
87.9
6.5
52.9
7.2
60.8
7.2
59.8
5.2
51.0
4.5
31.8
4.6
41.2
5.8
42.5
6.2
36.4
7.2
39.7
FREQUENCY
SEVERITY

CHART 20.


TREND OF ACCIDENT RATES—MOVING 5-YEAR TOTAL
BLAST FURNACES
FRE-QUENCY
SE-VERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
15
100
10
50
5
10
1
10.6
8.8
8.3
7.0
6.2
5.8
5.6
5.4
5.8
76.1
67.6
62.4
59.2
50.3
47.8
44.1
40.5
38.6
FREQUENCY
SEVERITY

BESSEMER DEPARTMENT.

Table 68 and Charts 21, 22, and 23 show the situation in the Bessemer department.

TABLE 68.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE BESSEMER DEPARTMENT, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	967	1	5	383	389	0.3	1.7	132.0	134.0	2.1	0.9	2.4	5.4
1910	5,070	20	18	1,943	1,981	1.3	1.2	127.7	130.2	7.9	.9	1.6	10.4
1911	5,155	6	24	1,237	1,267	.4	1.6	79.9	81.9	2.3	1.1	1.1	4.5
1912	6,521	9	37	1,892	1,938	.5	1.9	96.7	99.1	2.8	1.0	1.5	5.3
1913	6,885	16	42	1,610	1,668	.8	2.0	77.9	80.7	4.6	1.2	1.2	7.0
1914	4,470	6	25	685	716	.4	1.8	51.1	53.3	2.2	1.2	.9	4.3
1915	3,160	2	21	494	517	.2	2.2	52.1	54.5	1.3	1.4	.8	3.5
1916	4,070	13	34	848	894	1.1	2.8	69.5	73.4	6.4	2.1	1.2	9.7
1917	5,979	20	21	1,194	1,235	1.1	1.2	66.6	68.9	6.7	1.3	1.2	9.2
1918	5,881	13	18	877	908	.7	1.0	49.7	51.4	4.4	1.0	.8	6.2
1919	6,555	14	18	849	881	.7	.9	43.2	44.8	4.3	.5	.9	5.7
1920	6,907	5	9	750	764	.2	.4	36.2	36.3	1.4	.3	.6	2.3
1910 to 1914	28,101	57	146	7,367	7,570	.7	1.7	87.4	89.8	4.0	1.1	1.3	6.4
1915 to 1919	25,645	62	112	4,262	4,436	.8	1.5	55.4	57.7	4.8	1.1	1.0	6.9

The rates for this department are very erratic and seem to have been influenced more by the conditions prevalent during the war period than were other departments. The result is that the second five-year period somewhat exceeds in severity the earlier period although in frequency there was a satisfactory decline. The question ought always to be raised in such a case whether the falling frequency has not given a false idea of improvement when in fact the condition is actually becoming more hazardous. It is admittedly difficult to safeguard against some of the serious dangers which prevail in this department, but that much can be accomplished by persistent effort is proved by the experience of certain plants.

CHART 21.

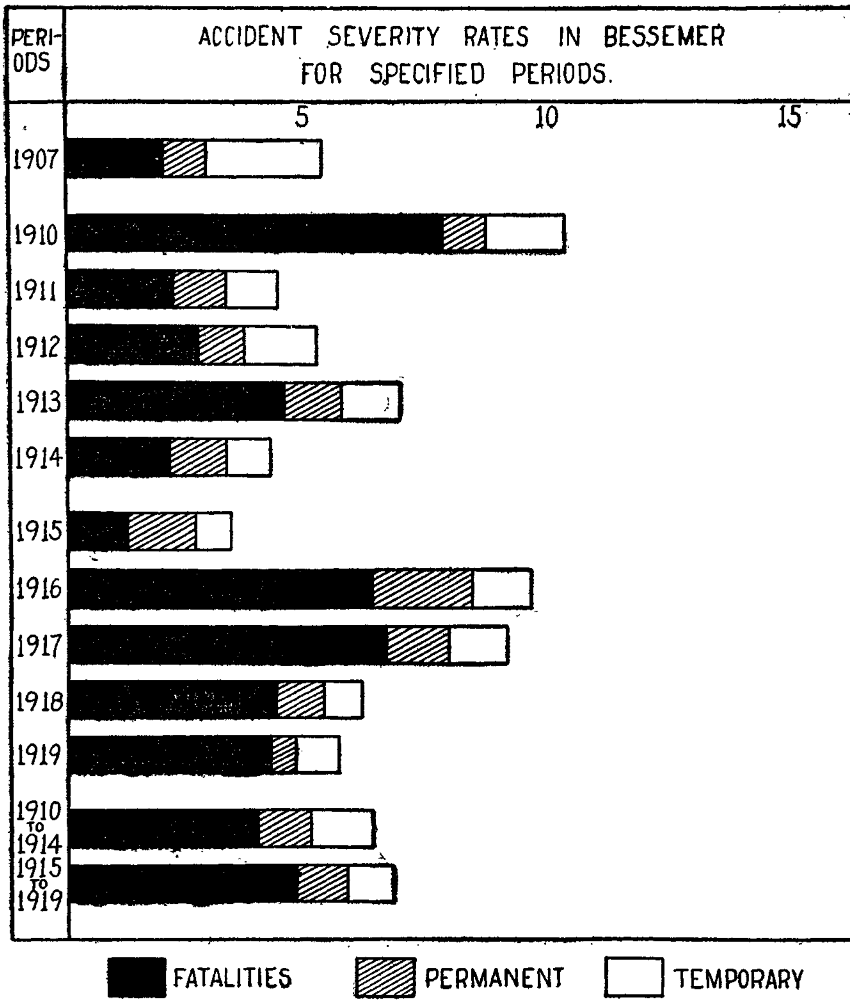

PERIODS
ACCIDENT SEVERITY RATES IN BESSEMER FOR SPECIFIED PERIODS.
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 22.

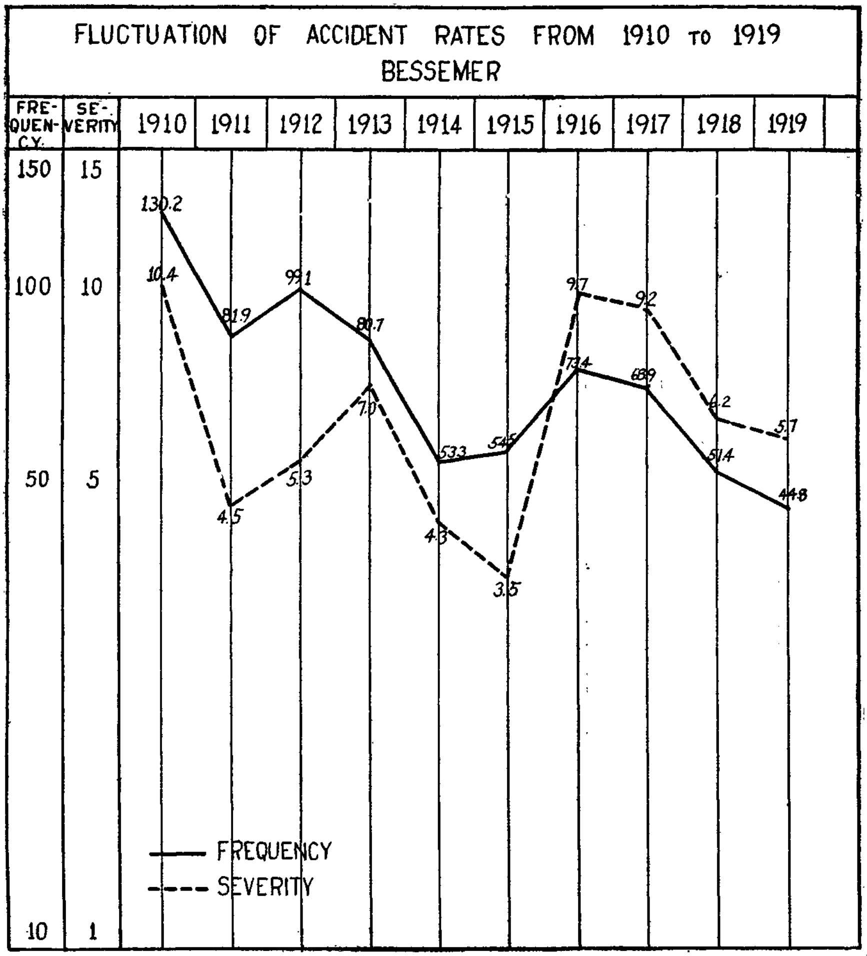
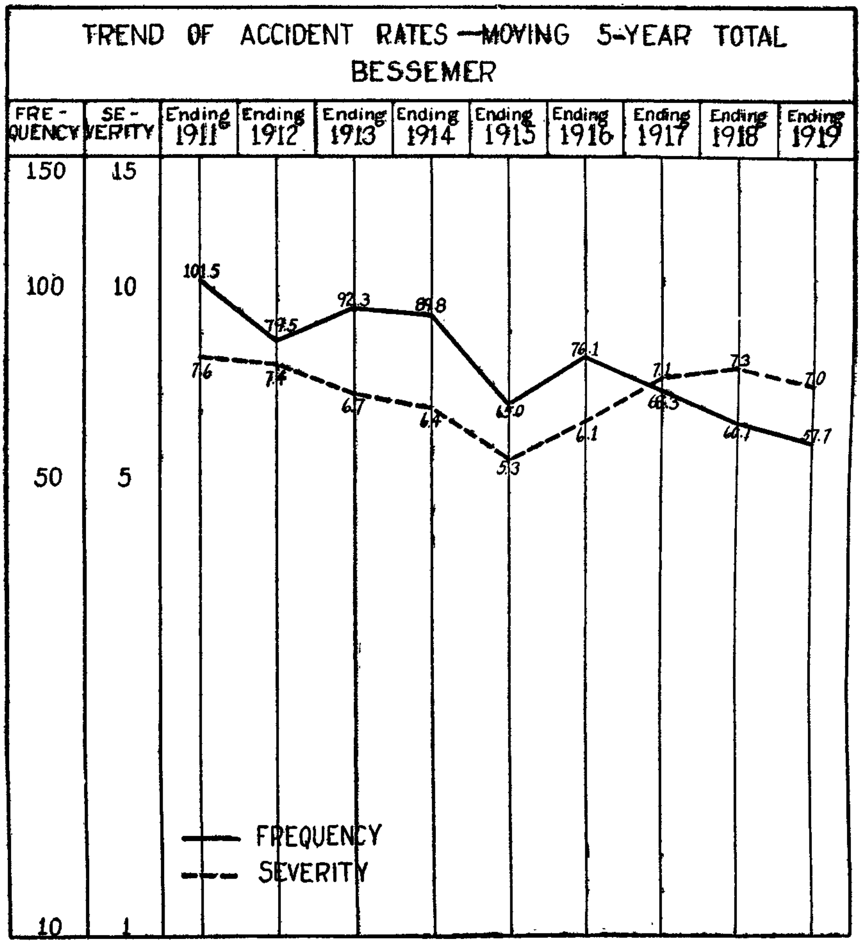

FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
BESSEMER
FREQUENCY
SEVERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
130.2
10.4
81.9
99.1
80.7
4.5
5.3
7.0
53.3
54.5
4.3
3.5
9.7
9.2
73.4
68.9
6.2
5.7
51.4
44.8
FREQUENCY
SEVERITY

CHART 23.



TREND OF ACCIDENT RATES—MOVING 5-YEAR TOTAL
BESSEMER
FREQUENCY
SEVERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
15
100
10
50
5
10
1
101.5
79.5
92.3
89.8
65.0
76.1
68.3
60.7
57.7
7.6
7.4
6.7
6.4
5.3
6.1
7.1
7.3
7.0
FREQUENCY
SEVERITY

OPEN HEARTHS.

Open hearths have a slightly decreased severity in the second five-year period, due to the decrease in permanent injury and temporary disability. Death slightly increases. The fluctuation chart shows a rather violent upward swing in the years 1917 and 1918. This is sufficient to give an upward trend at the close of the period even when five-year periods are considered.

TABLE 69.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR OPEN HEARTHS 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	2,987	14	14	908	936	1.6	1.6	101.3	104.5	9.3	4.0	1.1	14.4
1910	9,739	29	53	3,028	3,110	1.0	1.8	103.6	106.4	6.0	2.4	1.4	9.8
1911	10,718	18	45	1,890	1,953	.6	1.4	58.8	60.8	3.4	1.1	.9	5.4
1912	17,355	47	99	4,039	4,185	.9	1.9	77.6	80.4	5.3	1.9	1.0	8.2
1913	20,604	35	95	4,368	4,498	.6	1.5	70.7	72.8	3.4	1.4	1.0	5.8
1914	12,877	14	41	2,484	2,539	.4	1.1	64.3	65.8	2.2	1.5	.8	4.5
1915	5,969	8	20	832	860	.4	1.1	46.5	48.0	2.7	.9	.6	4.2
1916	9,654	12	37	1,458	1,507	.4	1.3	50.3	52.0	2.5	.8	.9	4.2
1917	21,457	47	86	3,187	3,320	.7	1.3	49.5	51.5	4.4	1.2	.8	6.4
1918	26,410	71	103	3,983	4,157	.9	1.3	50.3	52.5	5.4	1.4	1.1	7.9
1919	22,685	53	71	3,103	3,227	.8	1.0	45.6	47.4	4.7	1.3	.8	6.8
1920	28,823	43	70	3,164	3,277	.5	.8	37.0	38.3	3.0	.8	.5	4.3
1910 to 1914	71,293	143	333	15,809	16,285	.7	1.5	72.8	75.0	4.0	1.6	1.0	6.6
1915 to 1919	86,175	191	317	12,563	13,071	.7	1.2	48.6	50.5	4.4	1.2	.9	6.5

CHART 24.

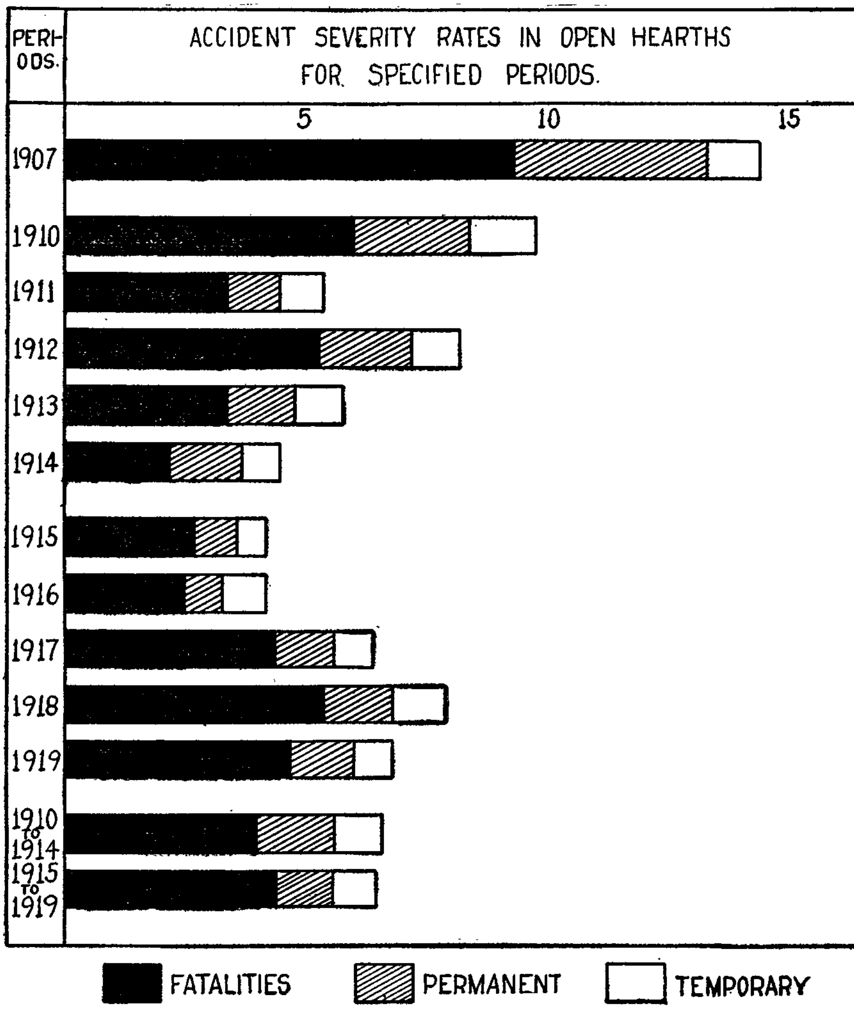

PERIODS.
ACCIDENT SEVERITY RATES IN OPEN HEARTHS FOR SPECIFIED PERIODS.
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 to 1914
1915 to 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 25.

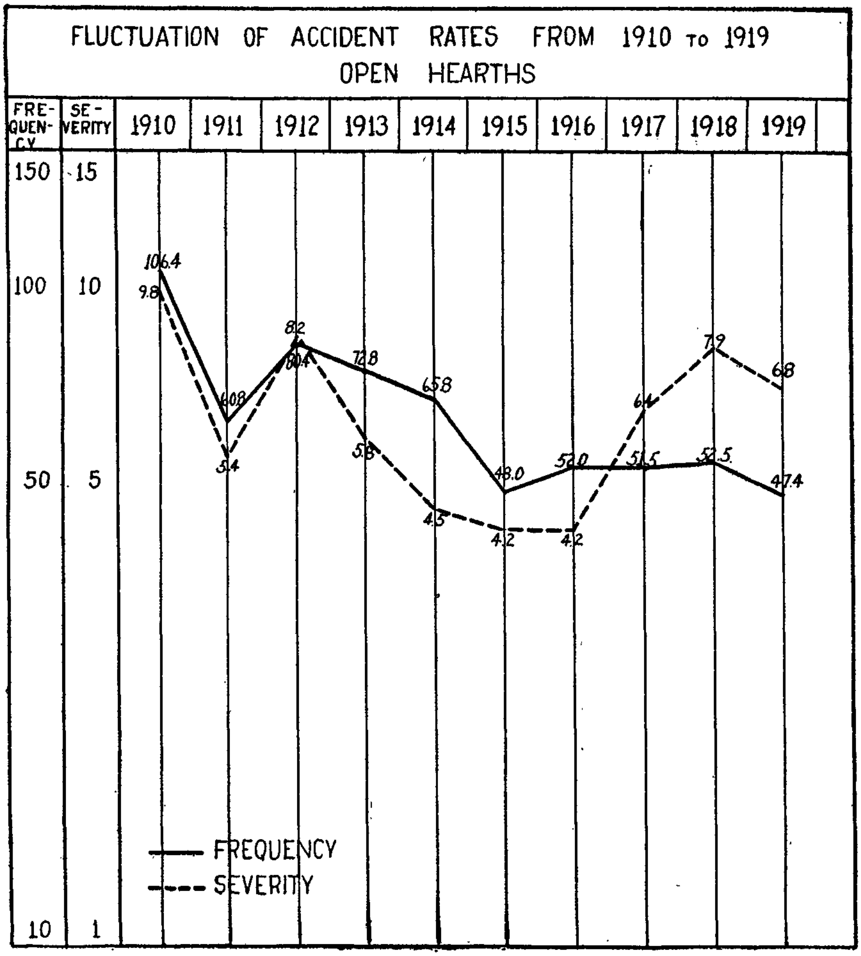
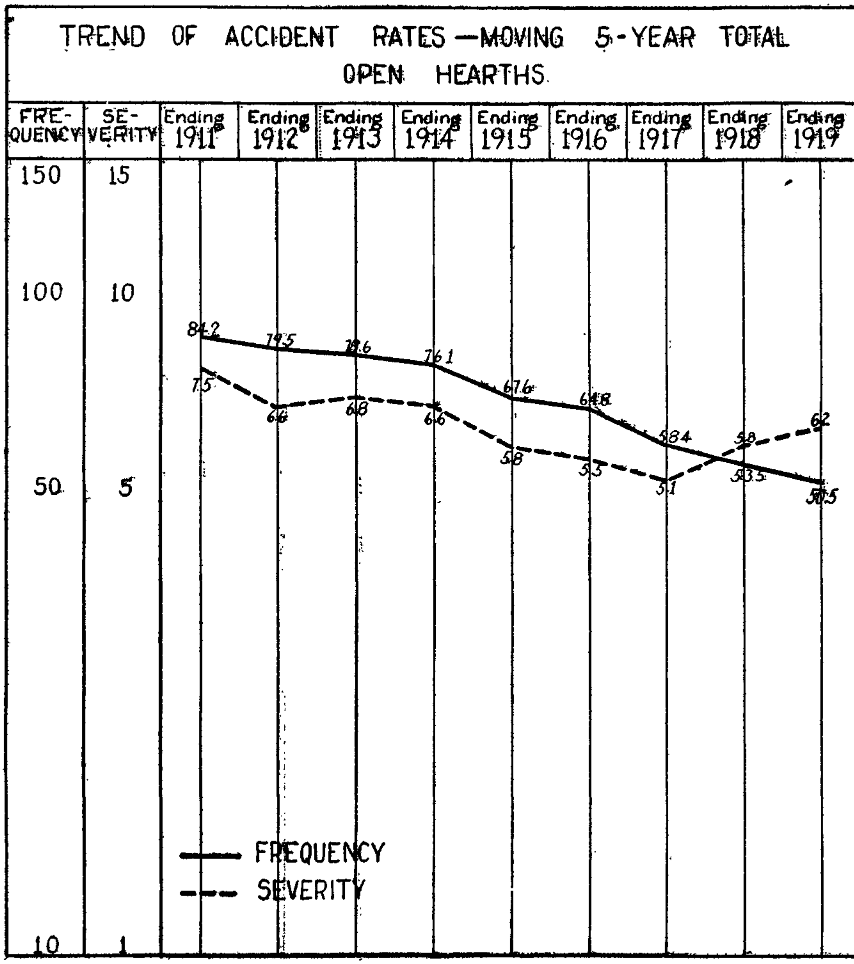

FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
OPEN HEARTHS
FRE-QUEN-CY
SE-VERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
106.4
9.8
60.8
5.4
8.2
80.4
72.8
5.8
65.8
4.5
48.0
4.2
52.0
4.2
6.4
51.5
7.9
52.5
6.8
47.4
FREQUENCY
SEVERITY

CHART 26.


TREND OF ACCIDENT RATES—MOVING 5-YEAR TOTAL
OPEN HEARTHS
FRE-QUENCY
SE-VERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
15
100
10
50
5
10
1
84.2
7.5
6.6
6.8
76.1
6.6
67.6
5.8
5.5
58.4
5.1
5.8
53.5
6.2
50.5
FREQUENCY
SEVERITY

FOUNDRIES.

The trend in accident rates for foundries is shown in Table 70 and Charts 27, 28, and 29.

TABLE 70.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR FOUNDRIES, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	939	1	3	179	183	0.4	1.1	63.5	65.0	2.1	0.3	1.0	3.4
1910	16,885	7	78	2,615	2,700	.1	1.5	51.6	53.2	.8	1.0	.6	2.4
1911	13,499	18	57	1,970	2,045	.4	1.4	48.6	50.4	2.7	1.0	.6	4.3
1912	23,294	23	135	4,512	4,670	.3	1.9	64.6	66.8	2.1	1.5	.8	4.4
1913	24,605	22	118	5,236	5,376	.3	1.6	70.9	72.8	1.7	1.2	.8	3.7
1914	17,634	14	61	3,432	3,507	.3	1.2	64.9	66.4	1.6	1.0	.7	3.3
1915	1,309	......	2	118	120	......	.5	30.0	30.5	......	.2	.4	.6
1916	1,231	1	6	145	152	.3	1.6	39.3	41.2	1.6	.6	.7	2.9
1917	31,805	45	101	6,810	6,956	.5	1.1	71.4	73.0	2.8	1.0	.9	4.7
1918	32,181	23	106	5,482	5,611	.2	1.1	56.8	58.1	1.5	1.0	.7	3.2
1919	24,220	15	62	4,048	4,125	.2	.9	55.7	56.8	1.2	.8	.7	2.7
1920	35,300	13	97	6,688	6,798	.1	.9	63.2	64.2	.7	.8	.8	2.3
1910 to 1914	95,917	84	449	17,765	18,298	.3	1.6	61.7	63.6	1.8	1.1	.7	3.6
1915 to 1919	92,746	84	277	16,604	16,965	.3	1.0	59.7	61.0	1.8	.9	.7	3.4

Foundries have a distinctly lower hazard than the departments already considered. The showing must be regarded as rather disappointing. The second five-year period has a very slightly lower severity rate, due entirely to a decline in the permanent injuries. A goodly number of foundries have made a record of declining severity but this is clearly overbalanced by the record in others in which the situation was not regarded as serious enough to demand strenuous effort. The fluctuation chart shows that the course of rates has been rather wildly erratic, particularly in the severity curve. This is accounted for in part by the fact that whenever the rate is low, due to a small number of deaths, when deaths do occur they influence the curve so much as to obscure the significance. It is particularly necessary in such cases to resort to some "smoothing" process which will give a more correct idea of the trend. Consulting the trend chart it becomes evident that the foundries here covered have gone along a nearly even course. They certainly do not exhibit any marked improvement.

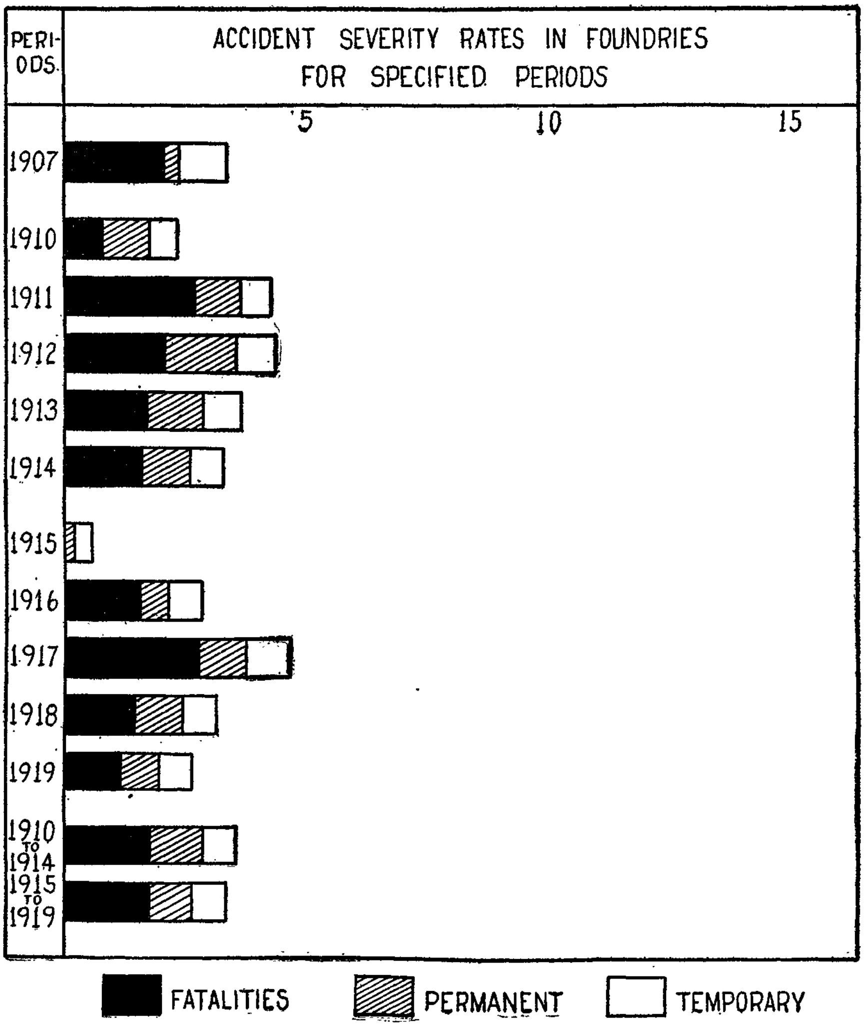
That improvement is possible and has been attained in certain cases is indicated by Table 71 in which occupational rates are shown for two periods. These cover the same plants and doubtless to a certain extent the same employees. Among cleaners there is a noteworthy decline in severity, which can be almost entirely attributed to the greatly extended use of protective goggles which has largely reduced the eye injuries formerly so common among this class of employees. The rates for core makers, who have a very low rate in any case, increased somewhat in frequency but declined in severity. The other occupations do not have any material change.

It must be suggested again that a declining frequency has perhaps obscured the fact that severity was not moving in the same direction.

TABLE 71.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR FOUNDRIES, 1910 TO 1914 AND 1917 TO 1919, BY OCCUPATIONS.

Occupation and period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
Cleaners:													
1910 to 1914...	4,196	4	60	2,153	2,217	0.3	4.8	171.1	176.2	1.9	3.9	1.6	7.4
1917 to 1919...	3,857	2	23	1,350	1,375	.2	2.0	116.7	118.9	1.0	2.3	1.3	4.6
Core makers:													
1910 to 1914...	1,273	......	1	241	242	......	.3	63.1	63.4	......	.4	.5	.9
1917 to 1919...	1,520	......	......	318	318	......	......	82.9	82.9	......	......	.6	.6
Melters and helpers:													
1910 to 1914...	1,261	......	8	220	228	......	2.1	58.2	60.3	......	1.8	.6	2.4
1917 to 1919...	1,778	1	4	260	265	.2	.7	48.7	49.6	1.1	.7	.6	2.4
Molders and helpers:													
1910 to 1914...	5,266	5	54	1,631	1,690	.3	3.4	103.2	106.9	1.9	3.0	1.1	6.0
1917 to 1919...	5,202	10	30	1,129	1,169	.6	1.9	72.8	75.3	3.8	1.1	1.0	5.9
Total, 1910 to 1914....	11,996	9	123	4,245	4,377	.3	3.4	118.0	121.7	1.5	2.9	1.1	5.5
Total, 1917 to 1919....	12,357	13	57	3,057	3,127	.4	1.4	82.5	84.3	2.1	1.3	1.0	4.4

CHART 27.



71087°—22——16

CHART 28.

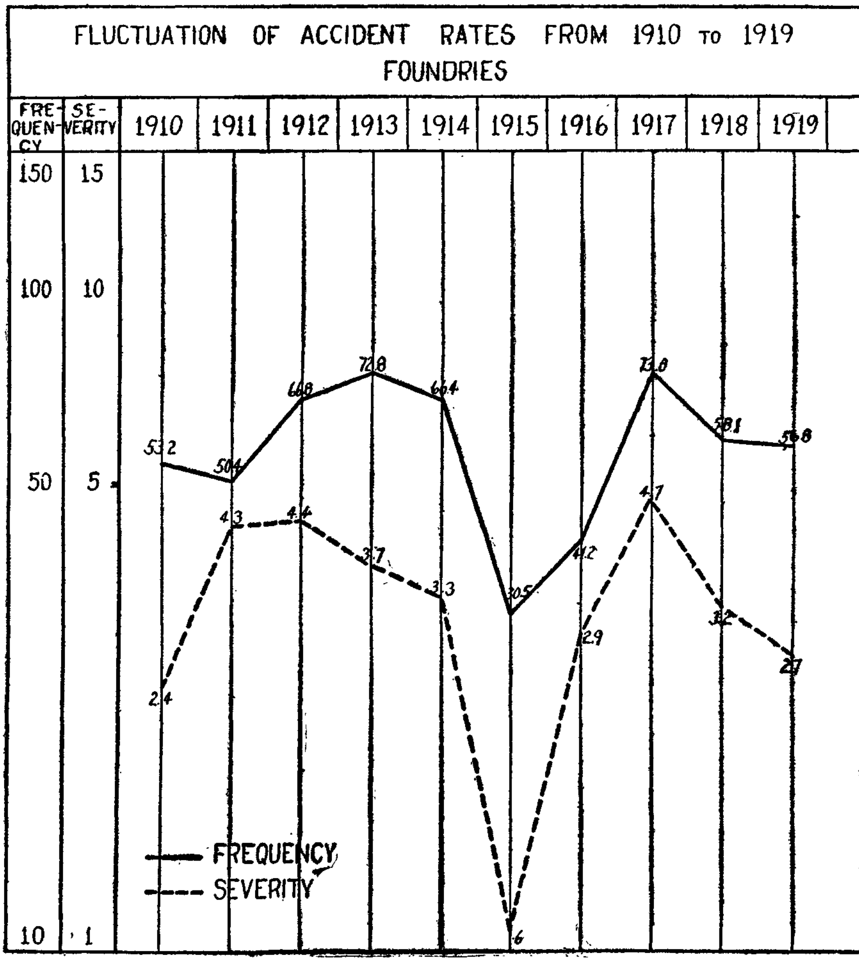
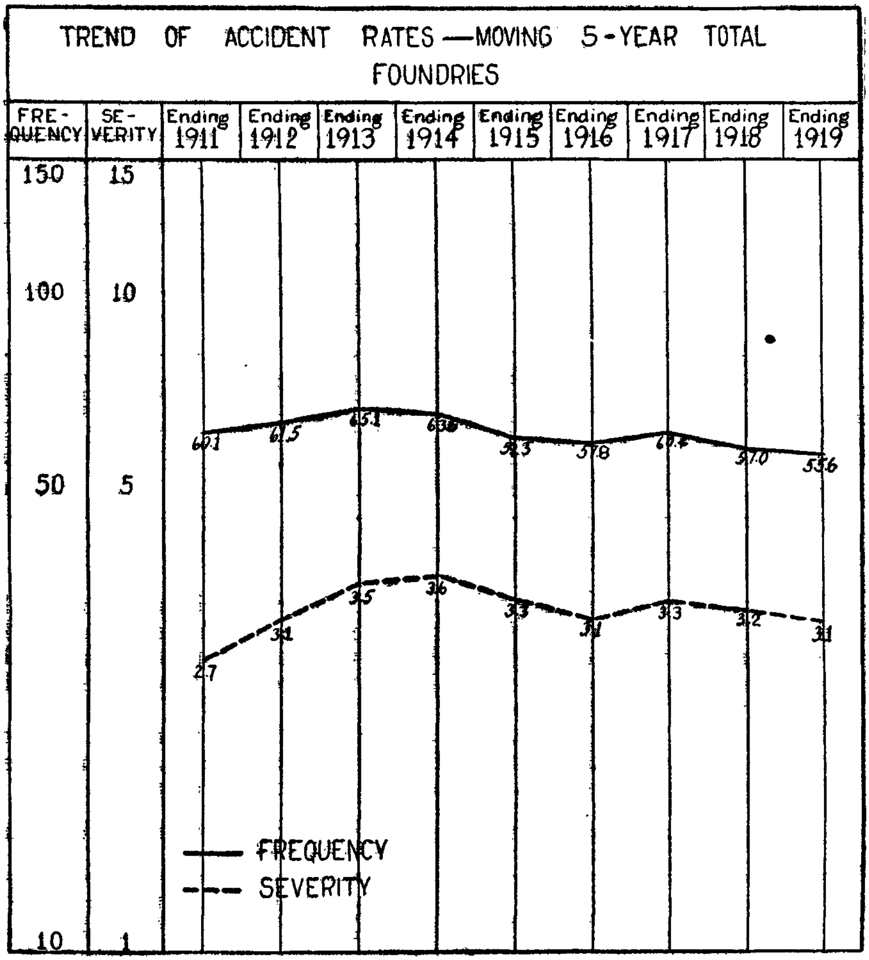

FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
FOUNDRIES
FREQUENCY
SEVERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
53.2
50.4
66.8
72.8
66.4
30.5
41.2
72.8
58.1
56.8
2.4
4.3
4.4
3.7
3.3
1.6
2.9
4.7
3.2
2.7
FREQUENCY
SEVERITY

CHART 29.


TREND OF ACCIDENT RATES—MOVING 5-YEAR TOTAL
FOUNDRIES
FRE-QUENCY
SE-VERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
15
100
10
50
5
10
1
FREQUENCY
SEVERITY

BAR MILLS.

Accident frequency and severity rates for bar mills for 1915 to 1920 are presented in Table 72.

TABLE 72.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR BAR MILLS, 1915 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1915	3,232	1	7	577	585	0.1	0.7	59.5	60.3	0.6	0.6	0.7	1.9
1916	3,042	4	11	783	798	.4	1.2	85.8	87.4	2.6	.5	1.1	4.2
1917	7,472	8	34	1,940	1,982	.4	1.5	86.5	88.4	2.1	1.0	1.0	4.0
1918	5,734	6	18	756	780	.3	1.0	43.9	45.2	2.1	.7	.7	3.5
1919	4,601	1	7	689	697	.1	.5	49.9	50.5	.4	.5	.7	1.6
1920	3,880	1	5	525	527	.1	.4	44.8	45.3	.5	.2	.5	1.2
1915 to 1919	24,081	20	77	4,745	4,842	.3	1.1	65.6	67.0	1.7	.7	.7	3.1

HEAVY ROLLING MILLS.

Severity in heavy rolling mills is slightly greater in the second of the two 5-year periods. When, however, the fluctuation chart and general trend are considered it will be evident that a really material improvement has been brought about, obscured by the intrusion of two bad years, 1915 and 1917.

In frequency there is an almost continuous decline when the 5-year periods are considered. During the war period an upward trend was established which, it may be hoped, has now come to an end.

TABLE 73.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR HEAVY ROLLING MILLS, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	4,556	8	10	874	892	0.6	0.7	64.0	65.3	3.5	0.3	1.0	4.8
1910	9,442	19	57	2,167	2,243	.7	2.0	76.5	79.2	4.0	1.5	1.0	6.5
1911	12,409	9	48	1,636	1,693	.2	1.3	43.9	45.4	1.4	.9	.7	3.0
1912	16,258	20	41	2,395	2,456	.4	.8	49.1	50.3	2.3	.9	.7	3.9
1913	17,569	16	60	1,910	1,986	.3	1.1	36.2	37.6	1.7	.6	.6	2.9
1914	11,985	10	55	899	964	.3	1.5	25.0	26.8	1.5	1.0	.4	2.9
1915	7,148	10	24	596	630	.5	1.1	27.8	29.4	2.8	1.0	.3	4.1
1916	10,076	7	44	959	1,010	.2	1.5	31.7	33.4	1.4	1.3	.5	3.2
1917	20,530	30	87	1,784	1,901	.5	1.4	29.0	30.9	2.9	1.0	.5	4.4
1918	19,807	24	67	1,900	1,991	.4	1.1	32.0	33.5	2.4	.9	.5	3.8
1919	17,605	20	53	1,711	1,784	.4	1.0	32.4	33.8	2.3	1.1	.5	3.9
1920	20,787	12	34	1,638	1,684	.2	.5	26.3	27.0	1.2	.4	.4	2.0
1910 to 1914	67,663	74	261	9,007	9,342	.4	1.3	44.4	46.1	2.1	.9	.6	3.6
1915 to 1919	75,166	91	275	6,950	7,316	.4	1.2	30.8	32.4	2.4	1.0	.5	3.9

CHART 30.

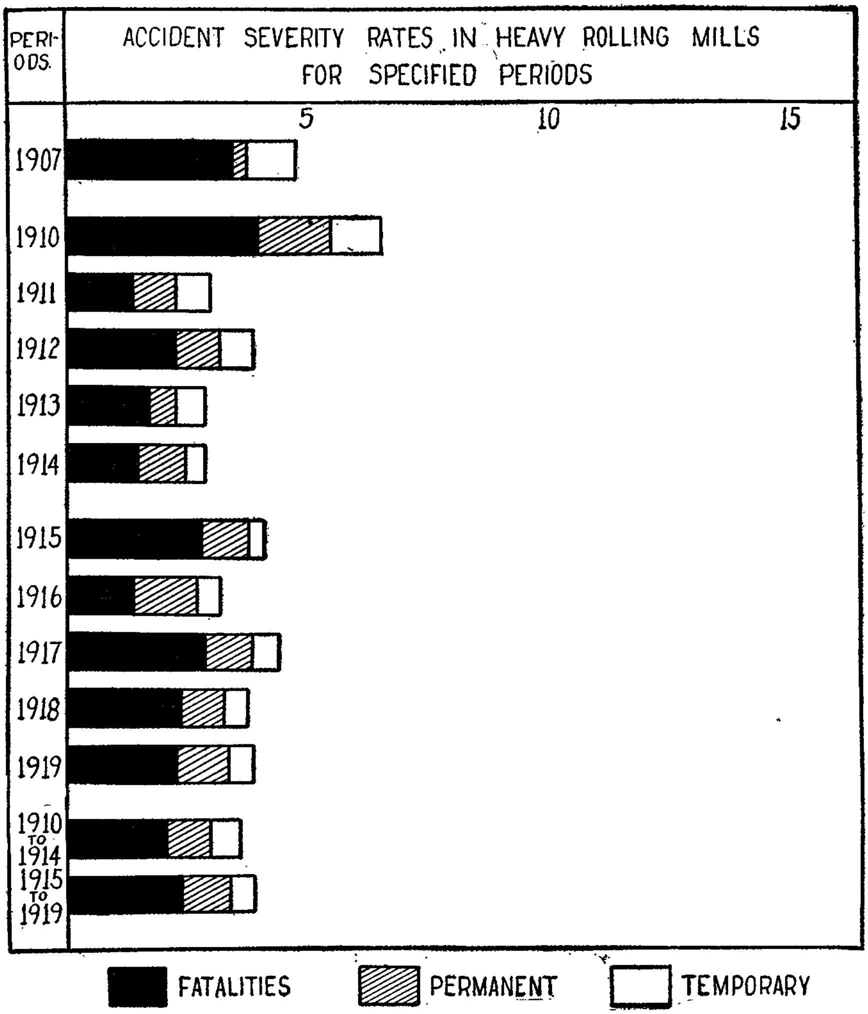

PERIODS.
ACCIDENT SEVERITY RATES IN HEAVY ROLLING MILLS FOR SPECIFIED PERIODS
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 31.

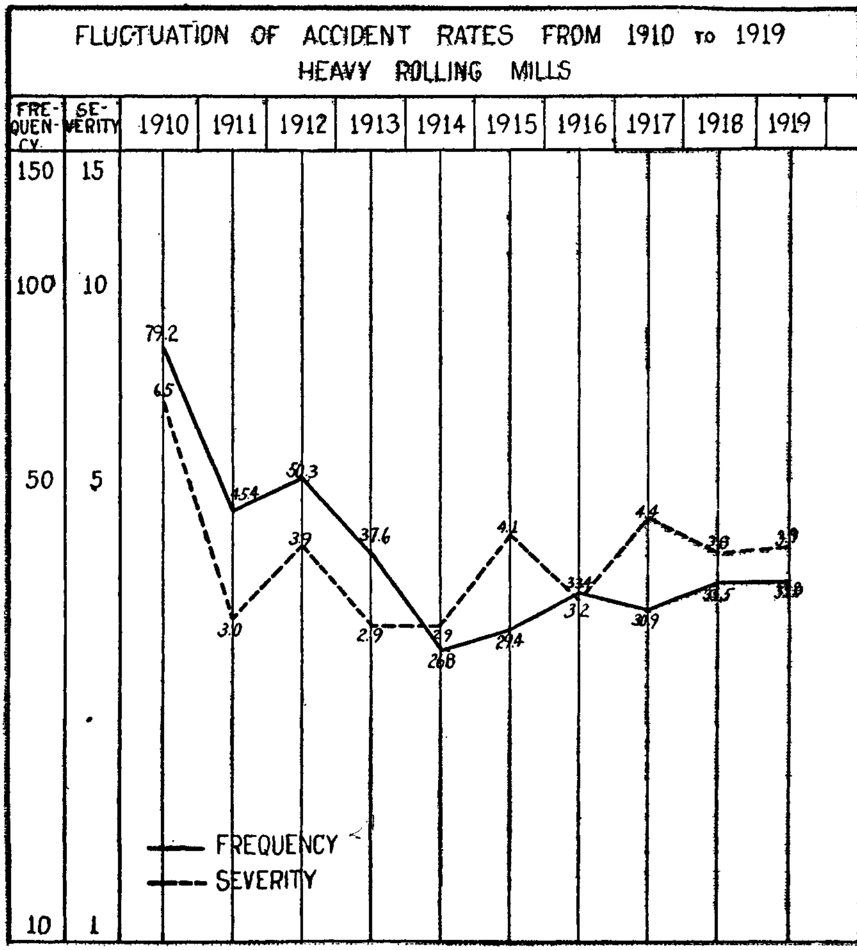

FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
HEAVY ROLLING MILLS
FRE-QUEN-CY
SE-VERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
79.2
6.5
45.4
50.3
3.0
3.9
37.6
2.9
2.9
26.8
4.1
29.4
3.4
3.2
4.4
30.9
FREQUENCY
SEVERITY

CHART 32.

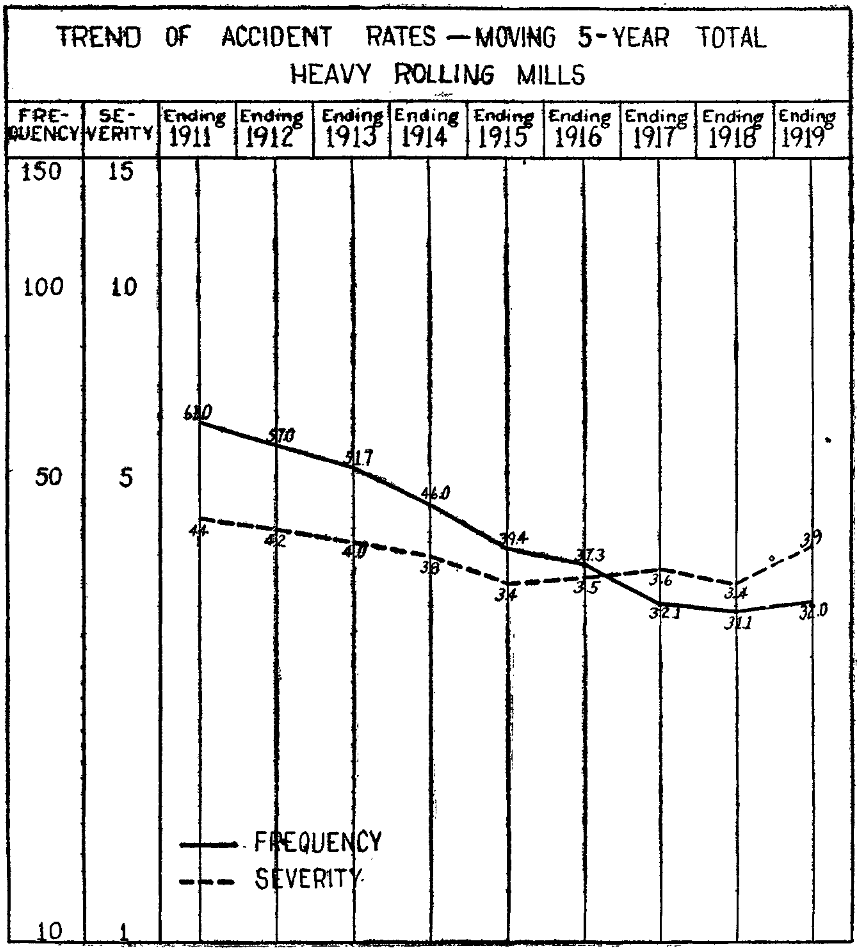

TREND OF ACCIDENT RATES — MOVING 5-YEAR TOTAL
HEAVY ROLLING MILLS
FREQUENCY
SEVERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
100
50
10
15
10
5
1
61.0
57.0
51.7
46.0
39.4
37.3
32.1
31.1
32.0
4.4
4.2
4.0
3.8
3.4
3.5
3.6
3.4
3.9
FREQUENCY
SEVERITY

PLATE MILLS.

No department shows a more pronounced and regular decline of severity than the plate mills during the earlier 5-year period. The department is not an exception to the usual rule that the war period is marked by a strong tendency to rising rates. This is probably accentuated by the fact that the great demand for ship plates led to the use of some rather improvised mills which could not, in the time available for their installation, be put in the best condition from the safety standpoint.

It will be observed that the rather sudden rise which occurred during the war, shown in the fluctuation chart, is almost entirely smoothed out when the overlapping 5-year periods are plotted.

TABLE 74.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR PLATE MILLS, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	1,915	4	12	637	653	0.7	2.1	110.9	113.7	4.2	3.7	1.2	9.1
1910	3,287	7	27	602	636	.7	2.7	61.1	64.5	4.3	1.6	.7	6.6
1911	4,390	5	15	590	610	.4	1.1	44.8	46.3	2.3	1.0	.6	3.9
1912	5,128	2	25	893	920	.1	1.6	58.0	59.7	.8	2.0	.8	3.6
1913	5,430	3	25	725	753	.2	1.5	44.5	46.2	1.1	1.2	.6	2.9
1914	3,476	2	13	319	334	.2	1.2	30.6	32.0	1.1	1.0	.5	2.6
1915	2,086	1	9	121	131	.2	1.4	19.3	20.9	1.0	.6	.3	1.9
1916	4,681	3	15	436	454	.2	1.1	31.0	32.3	1.3	.7	.5	2.5
1917	6,764	4	22	766	792	.2	1.1	37.7	39.0	1.2	.9	.5	2.6
1918	9,650	8	19	1,446	1,473	.3	.7	49.9	50.9	1.7	.6	.7	3.0
1919	11,892	9	24	1,247	1,280	.3	.7	35.0	36.0	1.5	.5	.5	2.5
1920	11,928	9	23	1,147	1,179	.3	.6	32.1	33.0	1.5	.6	.4	2.5
1910 to 1914	27,711	19	105	3,129	3,253	.3	1.6	48.0	49.9	1.8	1.4	.7	3.9
1915 to 1919	35,073	25	89	4,016	4,130	.2	.8	38.2	39.2	1.4	.6	.5	2.5

CHART 33.

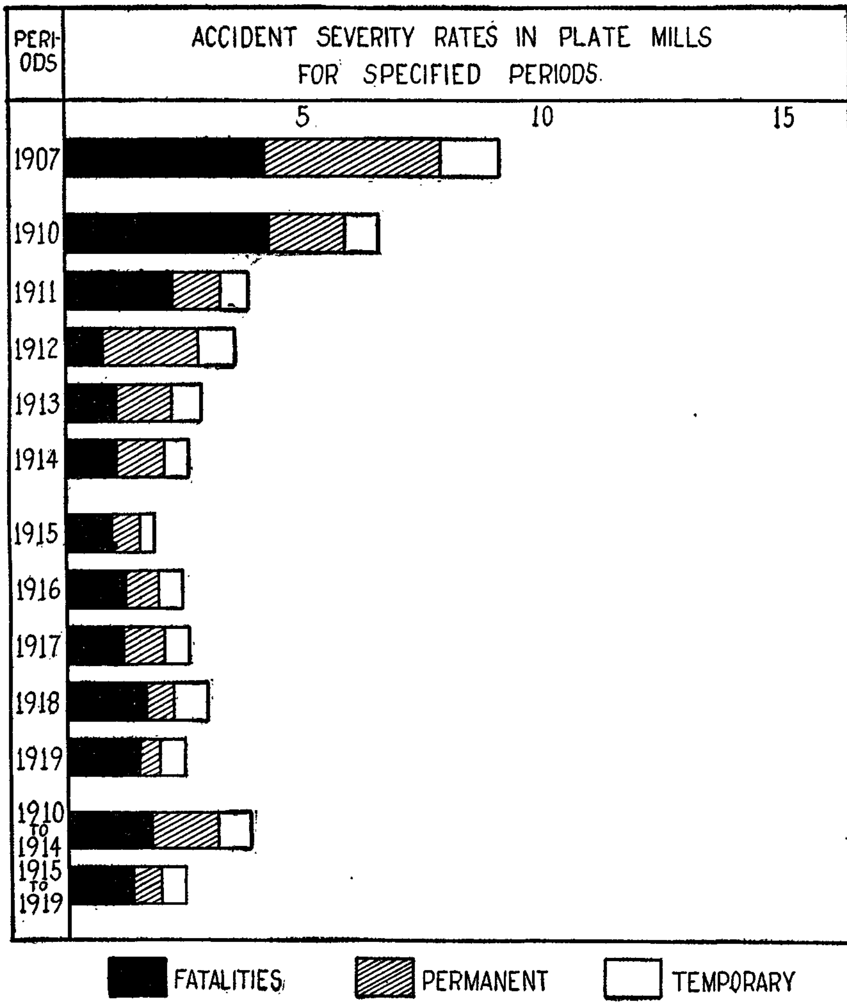
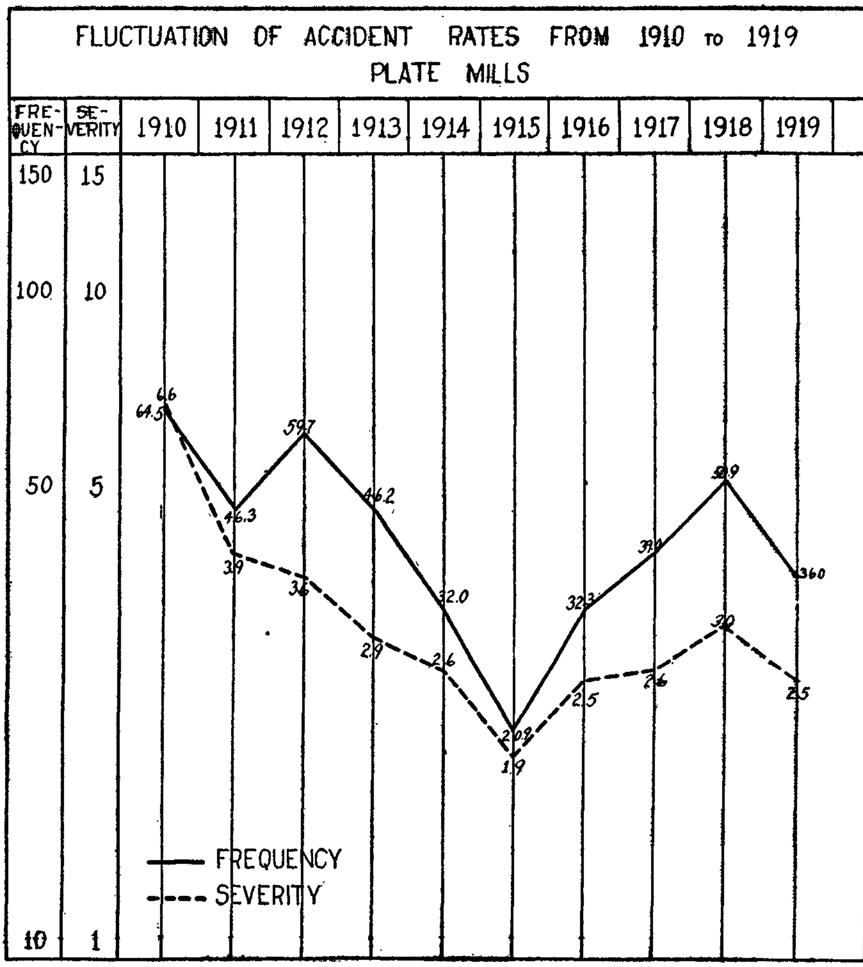
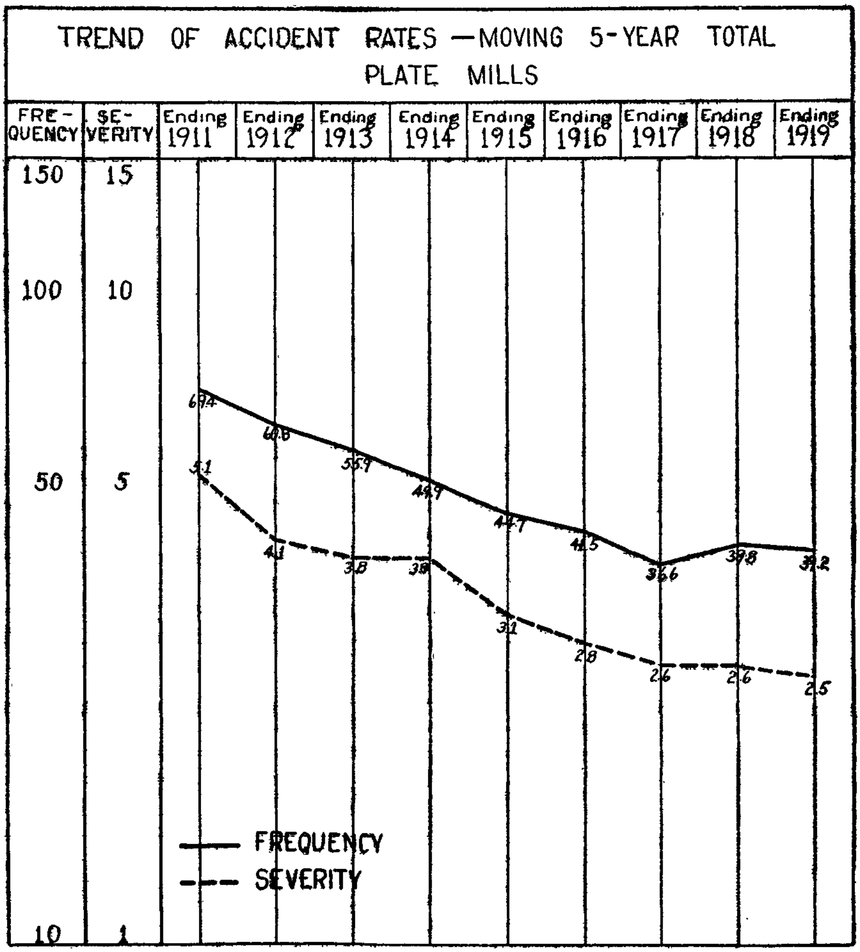

PERIODS
ACCIDENT SEVERITY RATES IN PLATE MILLS FOR SPECIFIED PERIODS.
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 34.



FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
PLATE MILLS
FREQUENCY
SEVERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
64.5
6.6
46.3
3.9
59.7
3.6
46.2
2.9
32.0
2.6
20.2
1.9
32.3
2.5
2.6
2.5

CHART 35.



PUDDLING MILLS.

The rates for puddling mills are not very satisfactory. They are based on a small exposure and it has not been possible to separate the accidents related to the puddling process from the rolling-mill cases which occurred in the rolling of the puddled iron into muck bar. It is quite probable that some of the deaths recorded for this department were due to the rolling-mill operations rather than to the puddling process. This process, while very laborious and only possible to men of considerable strength and endurance, does not give rise to a great number of serious accidents.

TABLE 75.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR PUDDLING MILLS, 1917 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1917	4,129	1	10	572	583	0.1	0.8	46.2	47.1	0.5	0.6	0.6	1.7
1918	2,712	3	4	370	377	.4	.5	45.5	46.4	2.2	.4	.6	3.2
1919	1,619	......	1	140	141	......	.2	28.8	29.0	......	.1	.4	.5
1920	2,007	1	10	243	254	.2	1.7	40.3	42.2	1.0	.8	.6	2.4
1917 to 1919	8,460	4	15	1,082	1,101	.2	.6	42.6	43.4	.9	.4	.6	1.9

ROD MILLS.

No data are available for rod mills prior to 1915. Since there has been in recent years considerable replacement of the older types of rod rolling mills by continuous mills, which do not require so many men for their operation and do not require them to occupy such dangerous positions, it may fairly be inferred that severity rates before 1915 were higher than they have been since.

The 5-year period covered is of course influenced by war conditions and the apparent lack of improvement may be less significant than it seems.

TABLE 76.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR ROD MILLS, 1915 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1915	2,062	......	10	229	239	......	1.6	37.0	38.6	......	0.7	0.5	1.2
1916	2,493	......	16	259	275	......	2.1	34.6	36.7	......	1.9	.5	2.4
1917	4,951	7	23	699	729	0.5	1.5	47.1	49.1	2.8	1.4	.5	4.7
1918	3,249	5	11	350	366	.5	1.1	35.9	37.5	3.1	1.0	.6	4.7
1919	2,463	2	10	184	196	.3	1.4	24.9	26.6	1.6	1.4	.5	3.5
1920	3,729	1	9	344	354	.1	.8	30.7	31.6	.5	.5	.4	1.5
1915 to 1919	15,218	14	70	1,721	1,805	.3	1.5	37.7	39.5	1.8	1.3	.5	3.6

SHEET MILLS.

The sheet mills present a very interesting situation. As compared with other departments they had low rates at the outset. The fluctuation chart shows these varying in accord with the usual experience but notably, and with a fair degree of steadiness, declining. This becomes more noticeable when the severity curve of the trend chart is considered. Only two 5-year periods show a rising rate and neither of these has a conspicuously rising rate.

Table 77 includes all occupations of the sheet mills, and the severity rate for the second 5 years is 1.5 days per 1,000 hours' exposure. Elsewhere it will appear that the characteristic operation of these mills, namely, sheet rolling, has an even lower rate (0.34 day). It is the common impression that the apparatus of the sheet mill has been but little modified in the course of time. In general appearance and in mode of operation this is quite true, but in capacity to do work and in safety to the worker there has been an important advance.

TABLE 77.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR SHEET MILLS, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	2,211	2	8	274	284	0.3	1.2	43.3	44.8	1.8	1.9	0.4	4.1
1910	18,501	28	52	3,310	3,390	.5	.9	59.6	61.0	2.9	.8	.6	4.3
1911	29,710	9	71	3,625	3,705	.1	.8	40.7	41.6	.7	.7	.4	1.8
1912	32,087	19	67	5,497	5,583	.2	.7	57.1	58.0	1.2	.7	.7	2.6
1913	25,938	21	67	3,717	3,805	.3	.9	47.8	49.0	1.6	.5	.6	2.7
1914	22,187	11	51	3,113	3,175	.2	.8	46.8	47.8	.9	.5	.6	2.0
1915	16,266	7	23	1,901	1,931	.1	.5	39.0	39.6	.9	.3	.5	1.7
1916	24,722	13	62	2,655	2,730	.2	.8	35.8	36.8	.6	.5	.5	1.6
1917	26,855	11	38	2,687	2,736	.1	.5	33.4	34.0	.8	.6	.5	1.9
1918	17,278	3	17	937	957	.1	.3	18.1	18.5	.3	.5	.2	1.0
1919	19,214	3	32	1,854	1,889	.1	.6	32.0	32.7	.3	.4	.4	1.1
1920	24,279	14	59	2,979	3,052	.2	.8	40.1	41.0	1.2	.7	.8	2.3
1910 to 1914	128,423	88	308	19,262	19,658	.2	.9	50.0	51.1	1.4	.6	.6	2.6
1915 to 1919	104,335	37	172	10,034	10,243	.1	.5	32.1	32.7	.7	.4	.4	1.5

CHART 36.

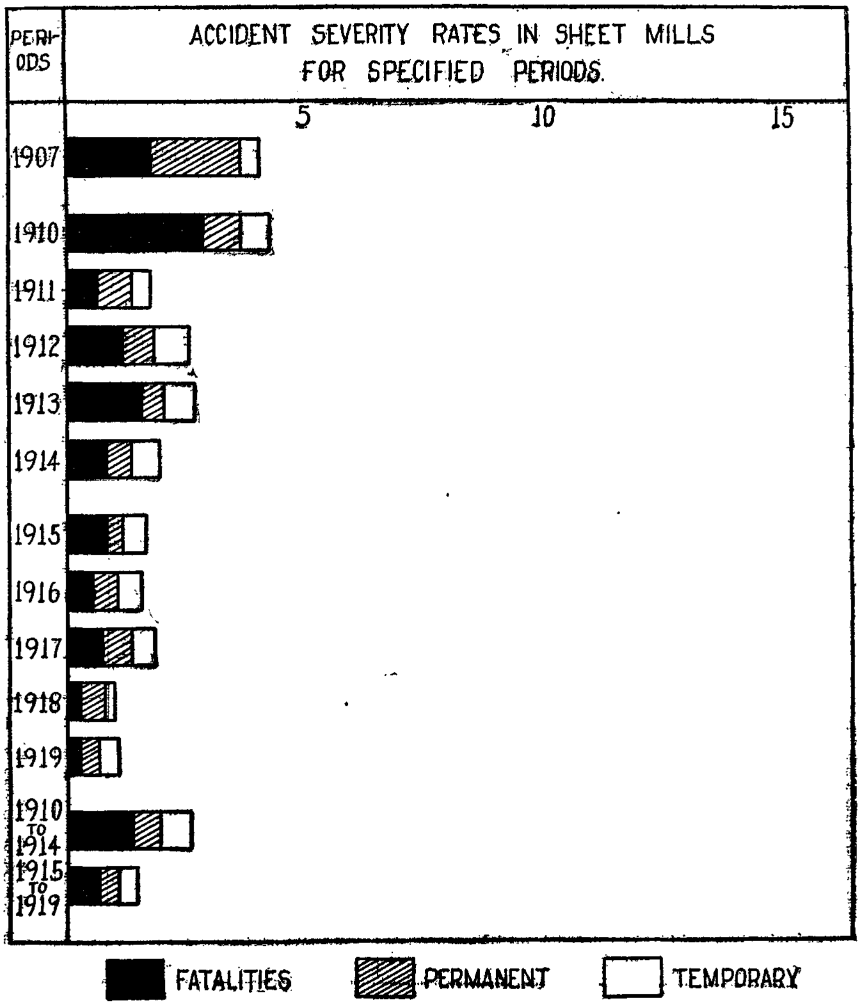

PERIODS
ACCIDENT SEVERITY RATES IN SHEET MILLS FOR SPECIFIED PERIODS.
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 37.

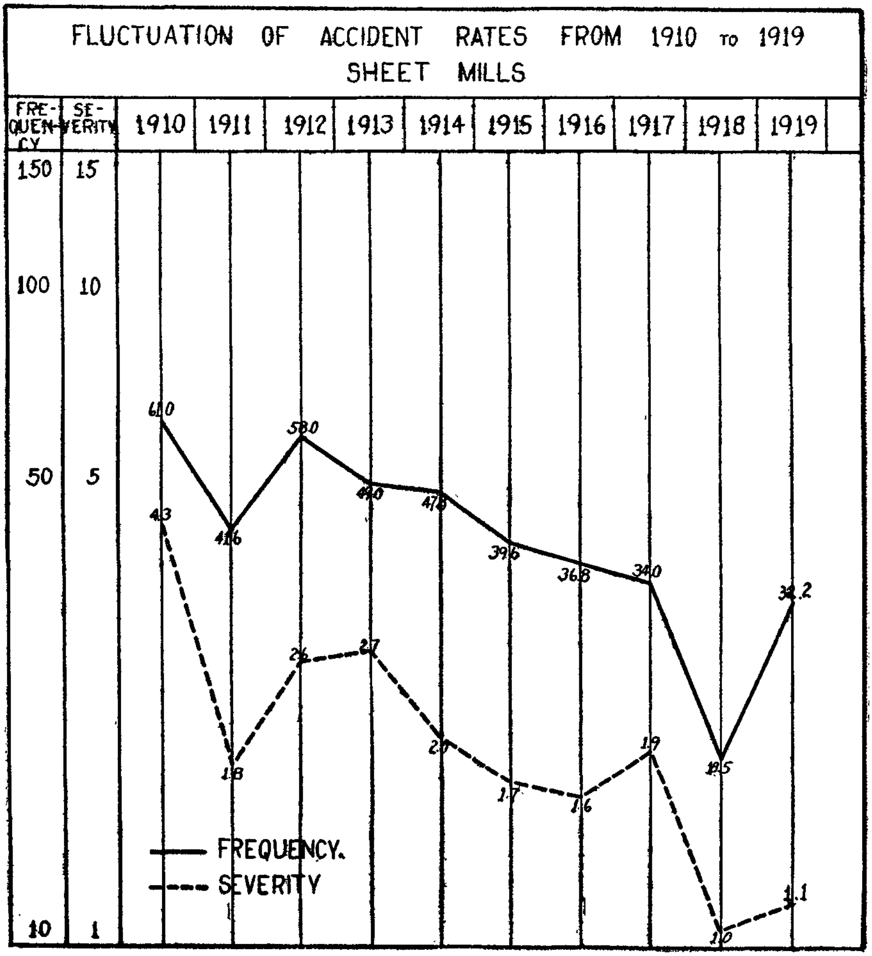
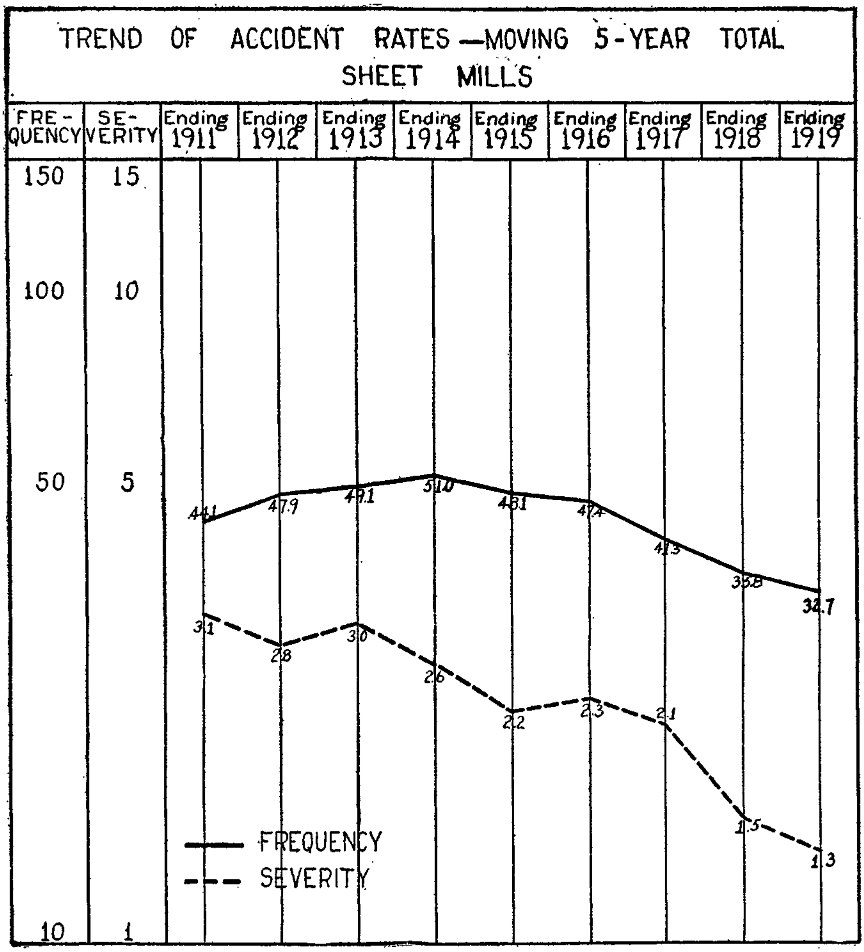

FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
SHEET MILLS
FREQUENCY
SEVERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
61.0
58.0
49.0
47.8
41.6
39.6
36.8
34.0
19.5
32.2
4.3
1.8
2.6
2.7
2.0
1.7
1.6
1.9
1.0
1.1
FREQUENCY.
SEVERITY

CHART 38.


TREND OF ACCIDENT RATES—MOVING 5-YEAR TOTAL
SHEET MILLS
FRE-QUENCY
SE-VERITY
Ending 1911
Ending 1912
Ending 1913
Ending 1914
Ending 1915
Ending 1916
Ending 1917
Ending 1918
Ending 1919
150
15
100
10
50
5
10
1
44.1
47.9
49.1
51.0
48.1
47.4
41.3
35.8
32.7
3.1
2.8
3.0
2.6
2.2
2.3
2.1
1.5
1.3
FREQUENCY
SEVERITY

TUBE MILLS.

The tube mills have nearly as low rates as the sheet mills, but they are much less regular. The fluctuation chart indicates that their range of variation was rather wide. This is due in part to the fact that the tube mill as ordinarily considered is made up of two rather distinct elements, (1) the furnaces and rolling and drawing apparatus and (2) the finishing floor, where the operations are more like those of a machine shop.

For some reason the tube mills were influenced by the conditions attending the war period to an unusual degree. In the year which seems on the whole to be the culmination of war-time conditions (1917) the rates both for frequency and severity shot up with surprising rapidity, subsiding, not so rapidly, the following year.

TABLE 78.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR TUBE MILLS, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	2,007	1	4	575	580	0.2	0.7	95.5	96.4	1.0	0.6	1.5	3.1
1910	9,767	3	25	1,608	1,636	.1	.9	54.9	55.9	.6	.4	.7	1.7
1911	13,676	1	53	2,080	2,134	.03	1.3	50.7	52.0	.2	.8	.5	1.5
1912	17,080	10	60	2,154	2,224	.5	1.2	42.0	43.7	1.3	.8	.5	2.6
1913	18,909	15	72	1,586	1,673	.3	1.3	28.0	29.6	1.6	.7	.4	2.7
1914	13,906	7	39	1,195	1,241	.2	.9	28.6	29.7	1.0	.6	.4	2.0
1915	7,109	2	21	182	205	.1	1.0	8.5	9.6	.6	.6	.2	1.4
1916	11,355	2	26	425	453	.1	.8	12.5	13.4	.4	.3	.3	1.0
1917	19,819	17	51	1,967	2,035	.3	.9	33.1	34.3	1.7	.5	.4	2.6
1918	18,499	8	41	1,127	1,176	.1	.7	20.3	21.1	.9	.4	.3	1.6
1919	18,326	9	39	1,127	1,172	.2	.7	20.4	21.3	1.0	.6	.3	1.9
1920	22,666	13	71	2,166	2,250	.2	1.0	31.9	33.1	1.1	.5	.5	2.1
1910 to 1914	73,338	36	249	8,623	8,908	.2	1.1	39.2	40.5	1.0	.7	.5	2.2
1915 to 1919	75,108	38	178	4,825	5,041	.2	.8	21.4	22.4	1.0	.5	.3	1.8

CHART 39.

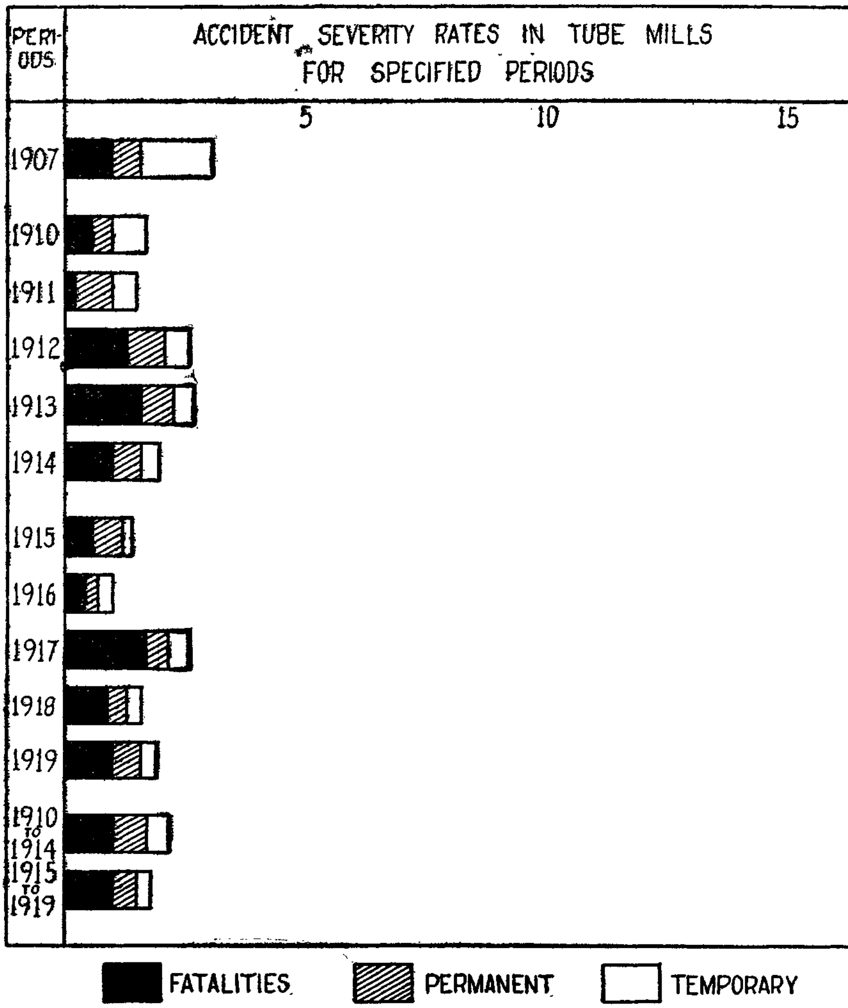
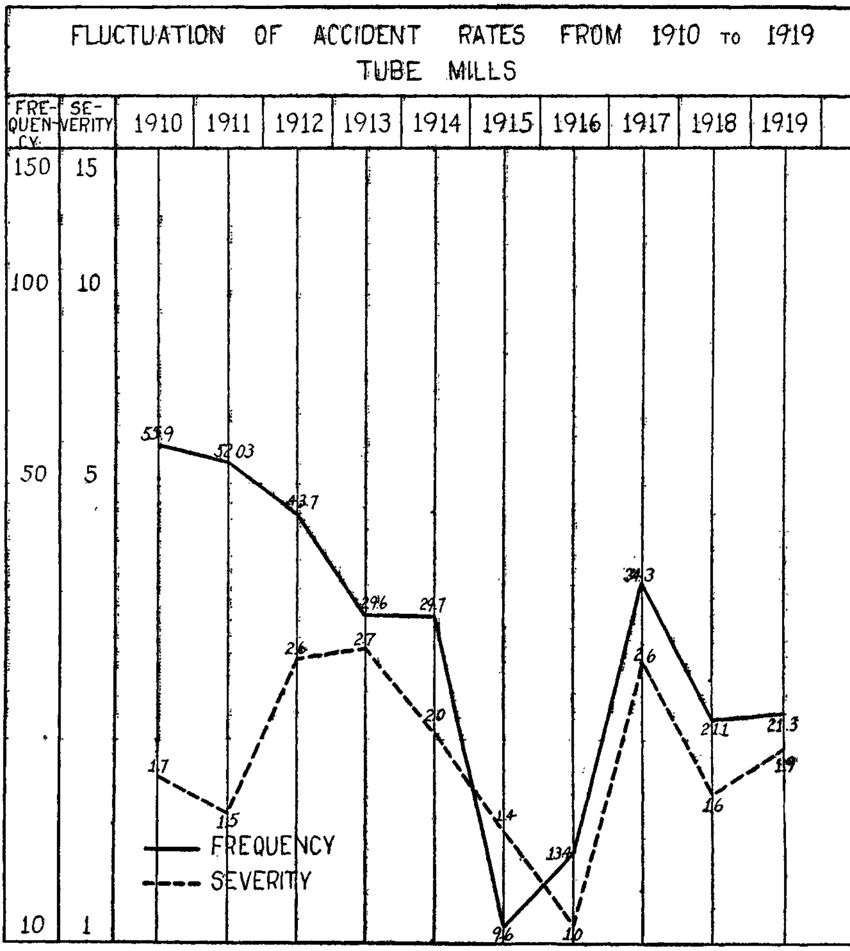

PERIODS
ACCIDENT SEVERITY RATES IN TUBE MILLS FOR SPECIFIED PERIODS
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 40


FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
TUBE MILLS
FRE-QUEN-CY
SE-VERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
55.9
52.03
43.7
29.6
29.7
9.6
13.4
34.3
21.1
21.3
1.7
1.5
2.6
2.7
2.0
1.4
1.0
2.6
1.6
1.9
FREQUENCY
SEVERITY

UNCLASSIFIED ROLLING MILLS.

The unclassified rolling mills are a miscellaneous group whose exact status it was not possible to determine. The showing is chiefly interesting because it reflects in considerable measure the situation in the mills which are hand operated as distinguished from those more largely mechanically operated.

When the two 5-year periods are contrasted, it is evident that a very material improvement has come about.

TABLE 79.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR UNCLASSIFIED ROLLING MILLS, 1910 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1910	14,434	15	49	4,861	4,925	0.3	1.1	112.3	113.7	2.1	1.6	1.3	5.0
1911	21,231	16	76	3,388	3,480	.3	1.2	53.2	54.7	1.5	1.1	.7	3.3
1912	22,909	16	76	4,660	4,752	.2	1.1	67.8	69.1	1.5	1.0	.9	3.4
1913	23,382	24	84	5,051	5,159	.3	1.2	72.0	73.5	2.0	1.1	1.0	4.1
1914	22,873	11	75	3,541	3,627	.2	1.1	51.6	52.9	1.0	.8	.7	2.5
1915	4,367	2	14	475	491	.2	1.1	36.2	37.5	.9	.5	.4	1.8
1916	8,082	5	25	922	952	.2	1.0	38.0	39.2	1.2	.6	.7	2.5
1917	27,978	10	60	4,265	4,335	.1	.7	50.8	51.6	.7	.7	.7	2.1
1918	37,163	22	74	4,015	4,111	.2	.7	36.0	36.9	1.2	.5	.5	2.2
1919	25,106	14	45	2,967	3,026	.2	.6	39.4	40.2	1.1	.4	.6	2.1
1920[1]	21,055	16	68	2,785	2,869	.3	1.1	44.1	45.4	1.5	.9	.5	2.9
1910 to 1914	104,829	82	360	21,501	21,943	.3	1.2	71.8	73.3	1.7	1.1	.9	3.7
1915 to 1919	102,696	53	218	12,644	12,915	.2	.7	41.0	41.9	1.0	.5	.6	2.1

[1] Subject to correction.

CHART 41.

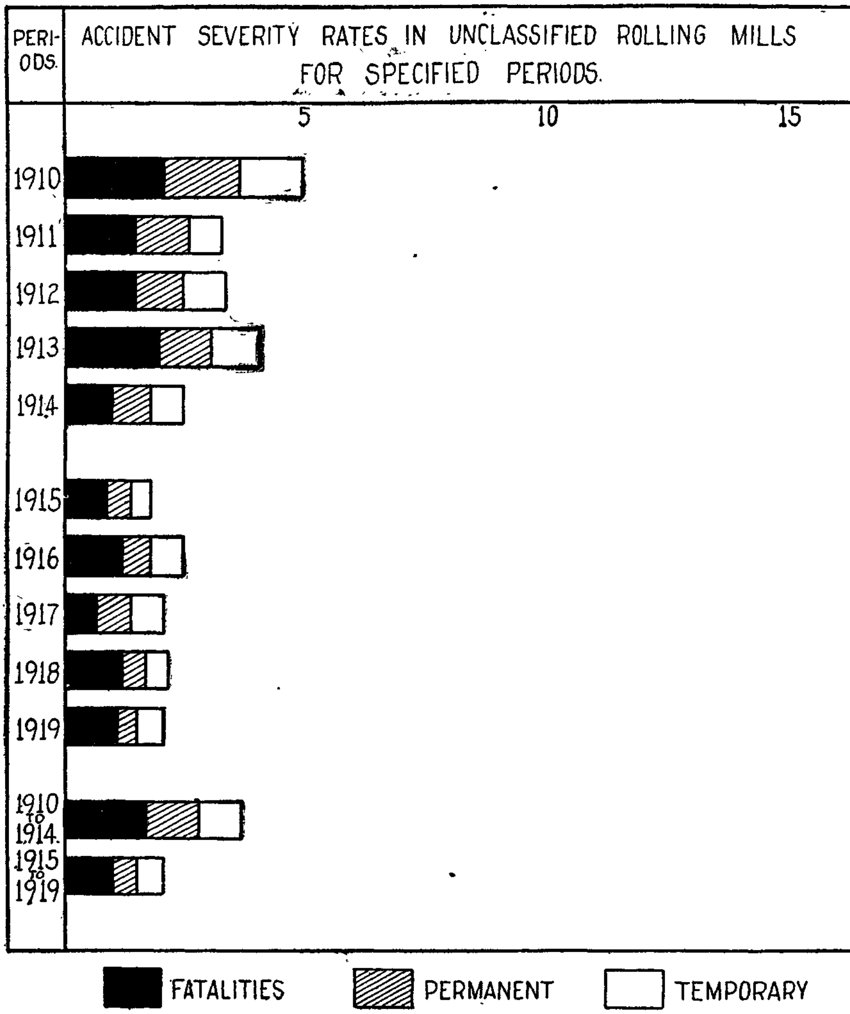
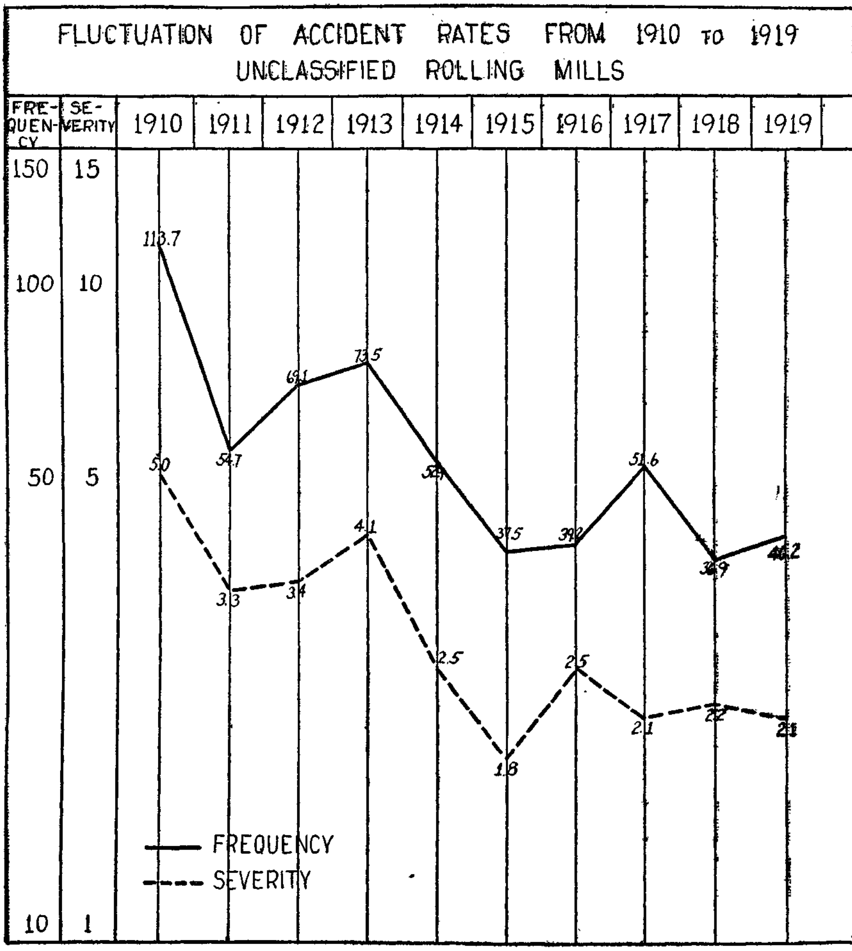

PERIODS.
ACCIDENT SEVERITY RATES IN UNCLASSIFIED ROLLING MILLS FOR SPECIFIED PERIODS.
5
10
15
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 to 1914.
1915 to 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 42.


FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
UNCLASSIFIED ROLLING MILLS
FRE-QUEN-CY
SE-VERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
113.7
54.7
69.1
73.5
51.6
37.5
39.2
36.9
41.2
5.0
3.3
3.4
4.1
2.5
1.8
2.5
2.1
2.2
2.1
FREQUENCY
SEVERITY

FABRICATING SHOPS.

The fabricating shops resemble in many particulars the machine-using mechanical departments. They differ in the amount of shifting that it is necessary to do by means of cranes. The handling of heavy girders seems to involve, as does crane operation in general, a considerable number of severe injuries. Of a severity rate in 1915-1919 of 18.55 days per 10,000 hours' exposure due to machinery in these shops, 12.46 days were due to the operation of cranes.

The second 5-year period shows a material improvement over the first.

TABLE 80.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR FABRICATING SHOPS, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	2,081	6	12	571	589	1.0	1.9	91.5	94.4	5.8	2.9	0.8	9.5
1910	8,713	11	33	3,901	3,945	.4	1.3	149.2	150.9	2.5	1.0	1.9	5.4
1911	19,530	8	92	3,244	3,344	.1	1.6	55.4	57.1	.7	1.0	.6	2.3
1912	28,988	32	119	6,890	7,041	.4	1.4	79.2	81.0	2.1	.9	.8	3.8
1913	30,470	34	104	7,368	7,506	.4	1.1	80.6	82.1	2.2	.8	.8	3.8
1914	20,837	13	77	4,103	4,193	.2	1.2	65.6	67.0	1.2	1.0	.7	2.9
1915	3,818	3	15	471	489	.3	1.3	41.1	42.7	1.6	.6	.7	2.9
1916	4,980	7	25	703	735	.5	1.7	47.1	49.3	2.8	.7	.9	4.4
1917	23,614	21	67	4,192	4,280	.3	.9	59.2	60.4	1.8	.6	.7	3.1
1918	29,166	22	29	5,077	5,128	.3	.3	58.0	58.6	1.5	.5	.6	2.6
1919	19,407	6	27	2,752	2,785	.1	.5	47.3	47.9	.7	.3	.5	1.5
1920	17,216	14	68	2,721	2,803	.2	1.3	52.7	54.2	1.6	1.1	.6	3.3
1910 to 1914	108,538	98	425	25,506	26,029	.3	1.3	78.3	79.9	1.7	.9	.8	3.4
1915 to 1919	80,985	59	163	13,195	13,417	.2	.7	54.3	55.2	1.5	.5	.6	2.6

CHART 43.

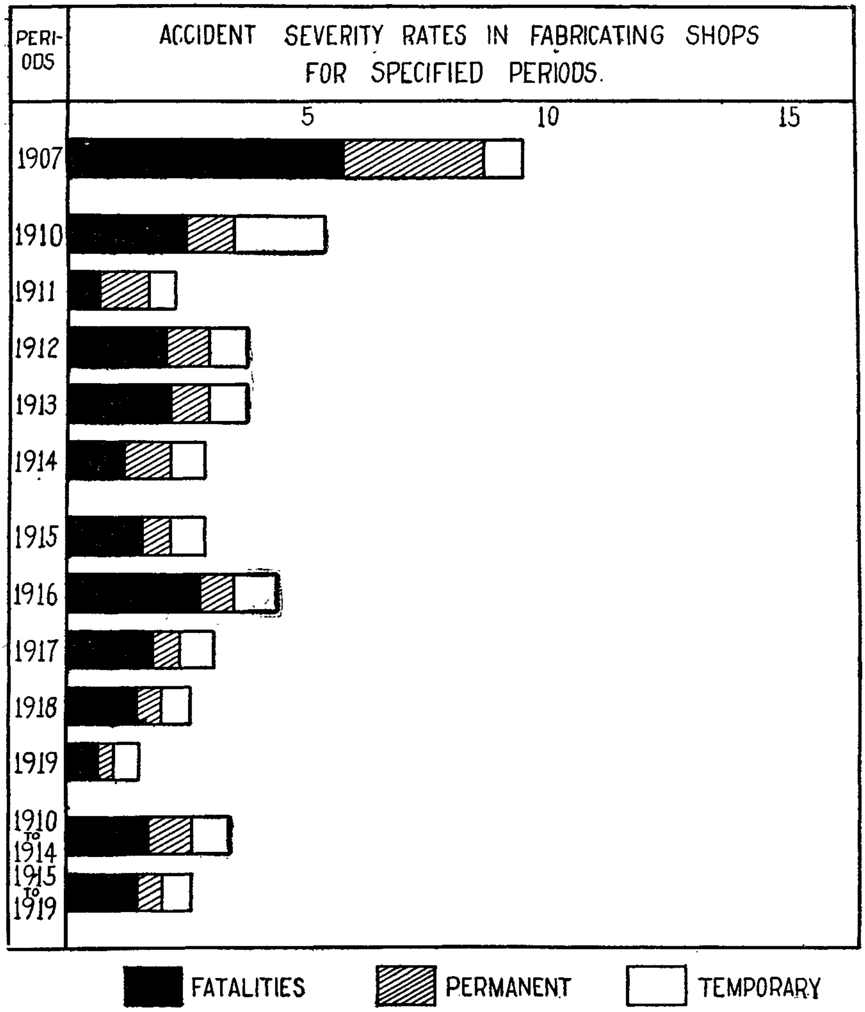
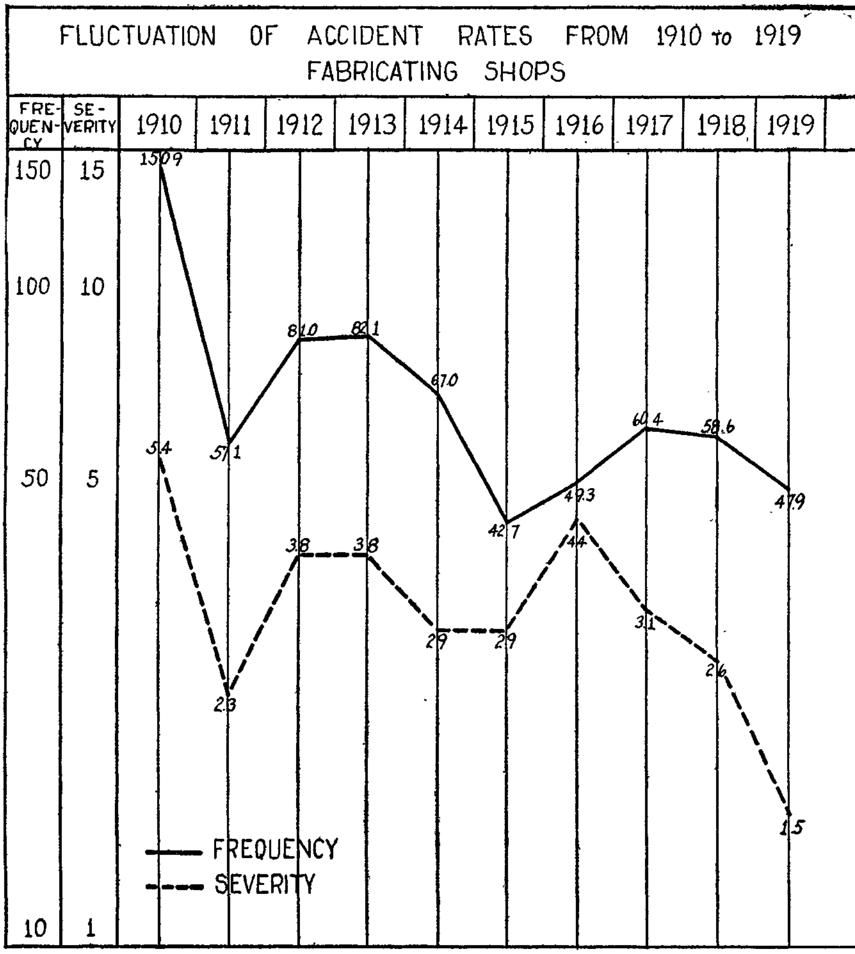

PERIODS
ACCIDENT SEVERITY RATES IN FABRICATING SHOPS FOR SPECIFIED PERIODS.
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 44.


FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
FABRICATING SHOPS
FREQUENCY
SEVERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
150.9
57.1
81.0
82.1
67.0
42.7
49.3
60.4
58.6
47.9
5.4
2.3
3.8
3.8
2.9
2.9
4.4
3.1
2.6
1.5
FREQUENCY
SEVERITY

FORGE SHOPS.

The accident fluctuation in forge shops from 1916 to 1920 is shown in Table 81.

TABLE 81.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR FORGE SHOPS, 1917 TO 1920, BY YEARS, AND 1910 TO 1919 BY PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1917	3,881	3	15	917	935	0.3	1.3	78.8	80.4	1.5	1.6	1.3	4.4
1918	6,408	4	26	1,009	1,039	.2	1.4	53.2	54.8	1.2	1.1	.7	3.0
1919	2,169	2	4	257	263	.3	.6	39.5	40.4	1.8	.3	.6	2.7
1920	2,197	......	5	380	385	......	.8	58.6	59.4	......	.8	.7	1.5
1910 to 1914	6,249	8	19	1,080	1,107	.4	1.0	57.6	59.0	2.6	.6	.7	3.9
1916 to 1919	12,667	9	45	2,189	2,243	.2	1.2	57.6	59.0	1.4	1.1	.9	3.4

WIRE DRAWING.

The most notable feature of the record for wire drawing is the large contribution to the severity rate made by permanent injury. This is conspicuous in each of the years covered by the record.

This is related to the liability of the worker to become entangled in the wire as it comes off the reel and moves toward the block. When so entangled there is every likelihood that, unless the machine is provided with a stop such as is made a part of the design in modern practice, the worker may lose a hand, a foot, or at least a finger. There are still enough draw benches of the older type, to which no stop has been applied, to maintain the excess in this matter of permanent injury.

The fluctuation chart shows that after an initial rapid rise in the war period there was a most striking decline in both frequency and severity.

TABLE 82.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR WIRE DRAWING, 1910 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1910	10,370	5	84	2,323	2,412	0.2	2.7	74.7	77.6	1.0	2.6	0.7	4.3
1911	11,819	4	89	2,270	2,363	.1	2.3	59.0	61.4	.6	2.0	.6	3.2
1912	13,059	4	104	2,627	2,735	.1	2.7	67.1	69.9	.6	2.5	.7	3.8
1913	12,769	6	59	2,542	2,607	.2	1.5	66.4	68.1	.9	1.1	.7	2.7
1914	11,468	2	47	1,742	1,791	.1	1.4	50.6	52.1	.4	1.3	.5	2.2
1915	7,859	1	62	1,831	1,894	.03	2.6	77.7	80.3	.3	2.4	.8	3.5
1916	9,551	4	104	1,764	1,872	.1	3.6	61.6	65.3	.8	2.9	.6	4.3
1917	13,727	3	63	1,700	1,766	.1	1.5	41.3	42.9	.4	1.0	.6	2.0
1918	12,790	4	60	991	1,055	.1	1.6	25.8	27.5	.6	1.2	.4	2.2
1919	8,739	......	32	626	658	......	1.2	23.9	25.1	......	1.0	.4	1.4
1920	13,243	2	63	1,252	1,317	.1	1.6	31.5	33.2	.3	1.7	.5	2.5
1910 to 1914	59,481	21	383	11,504	11,908	.1	2.1	63.5	65.7	.7	1.9	.6	3.2
1915 to 1919	52,666	12	321	6,912	7,245	.1	2.0	43.7	45.8	.5	1.6	.5	2.6

CHART 45.

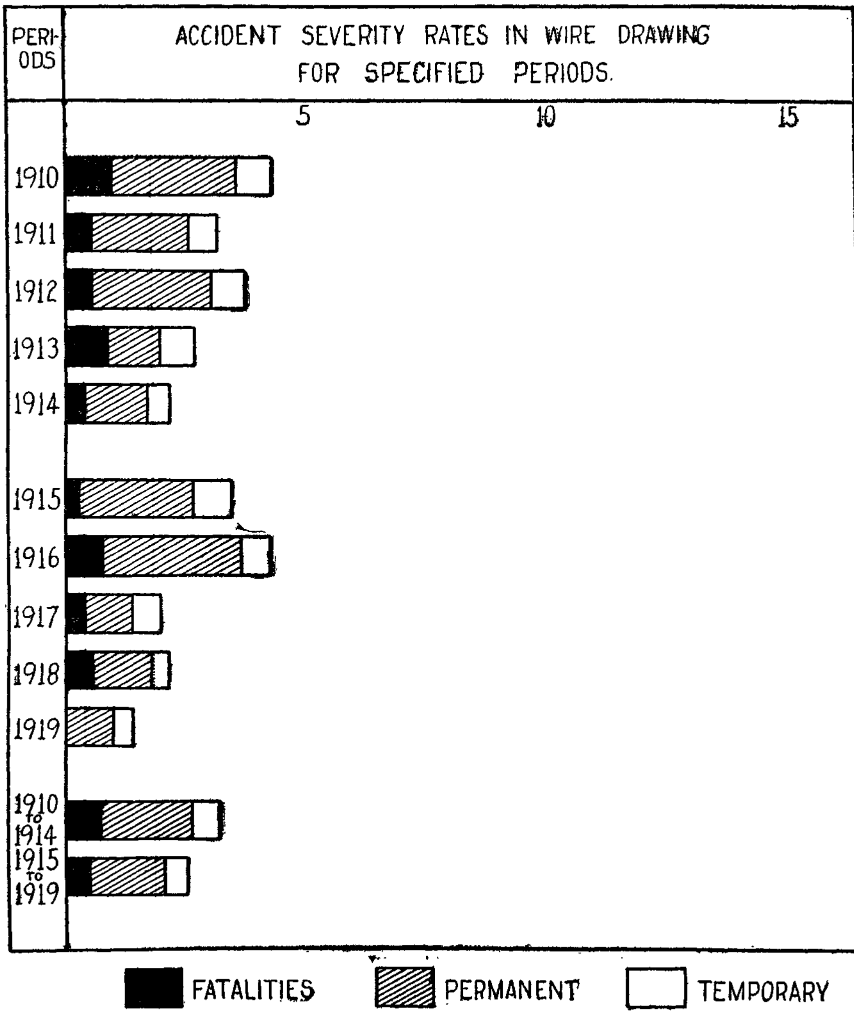
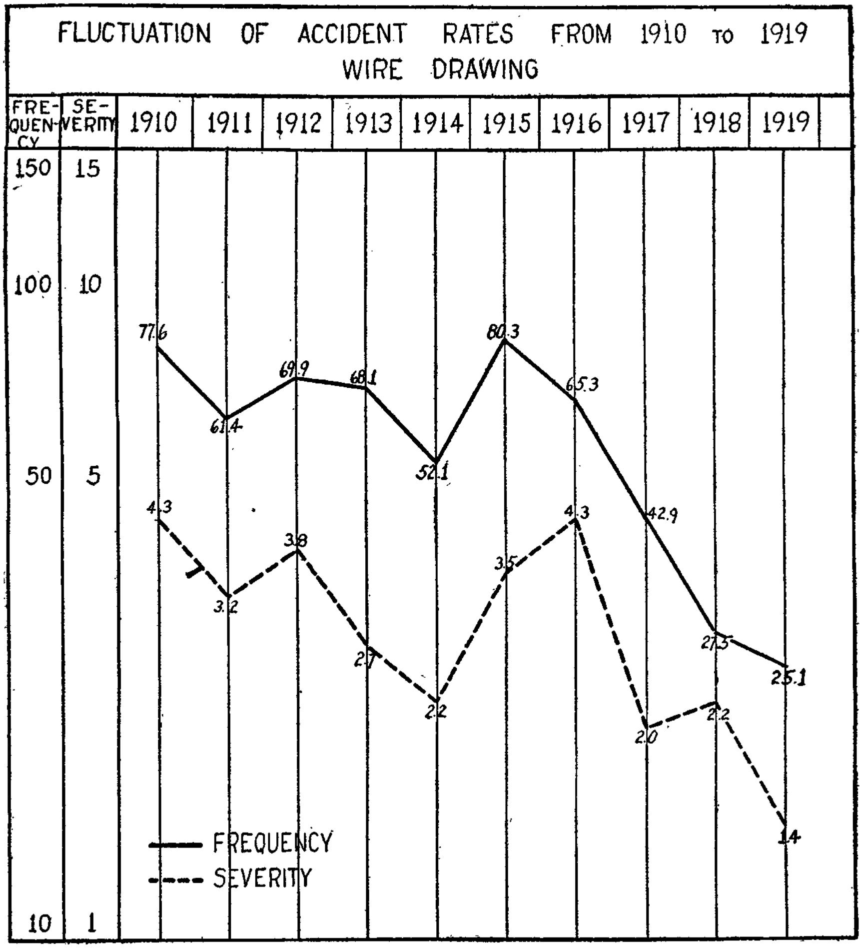

PERIODS
ACCIDENT SEVERITY RATES IN WIRE DRAWING FOR SPECIFIED PERIODS.
5
10
15
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 to 1914
1915 to 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 46.


FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
WIRE DRAWING
FREQUENCY
SEVERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
77.6
61.4
69.9
68.1
52.1
80.3
65.3
42.9
27.5
25.1
4.3
3.2
3.8
2.7
2.2
3.5
4.3
2.0
2.2
1.4
FREQUENCY
SEVERITY

ELECTRICAL DEPARTMENT.

The record for the electrical department is a distinct disappointment. The severity is high and there is no indication of any improvement. The exposure to fatal electric shock is reflected in the irregularity of the rate and the proportion of it which is attributable to deaths.

It has been demonstrated by some companies that the work of this department can be carried on with a much greater degree of safety than is indicated by this record. In another smaller group which has been studied regarding the matter of causes of injury to these workers the severity rate of the latter 5-year period shown in the table is 5.2 days instead of 7.2 days. Since the smaller group is included in the larger it is evident that there is a section of the industry in which conditions for the electrical workers are distinctly bad.

TABLE 83.—ACCIDENT FREQUENCY AND SEVERITY RATES IN THE ELECTRICAL DEPARTMENT, 1910 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1910	1,526	2	3	282	287	0.4	0.7	61.6	62.7	2.6	0.9	0.7	4.2
1911	2,760	3	9	356	368	.4	1.1	43.0	44.5	2.2	.9	.5	3.6
1912	3,796	6	15	523	544	.5	1.3	45.9	47.7	3.1	1.7	.5	5.3
1913	4,012	14	15	495	524	1.2	1.2	41.1	43.5	7.0	1.2	.5	8.7
1914	2,327	8	6	301	315	1.1	.9	43.1	45.1	6.9	1.0	.5	8.4
1915	612	1	1	23	25	.5	.5	12.5	13.5	3.3	.2	.1	3.6
1916	1,635	6	6	289	301	1.2	1.2	58.9	61.3	7.3	.4	.8	8.5
1917	4,385	16	16	571	603	1.2	1.2	43.4	45.8	7.3	1.3	.7	9.3
1918	4,747	10	10	485	505	.7	.7	34.1	35.5	4.2	1.1	.4	5.7
1919	4,644	13	7	483	503	.9	.5	34.7	36.1	5.6	.9	.5	7.0
1920	4,473	5	3	403	411	.4	.2	30.0	30.6	2.2	.1	.4	2.7
1910 to 1914	14,921	33	48	1,957	2,038	.8	1.1	45.2	47.1	4.6	1.2	.5	6.3
1915 to 1919	16,023	46	40	1,851	1,937	1.0	.8	38.5	40.3	5.7	1.0	.5	7.2

CHART 47.

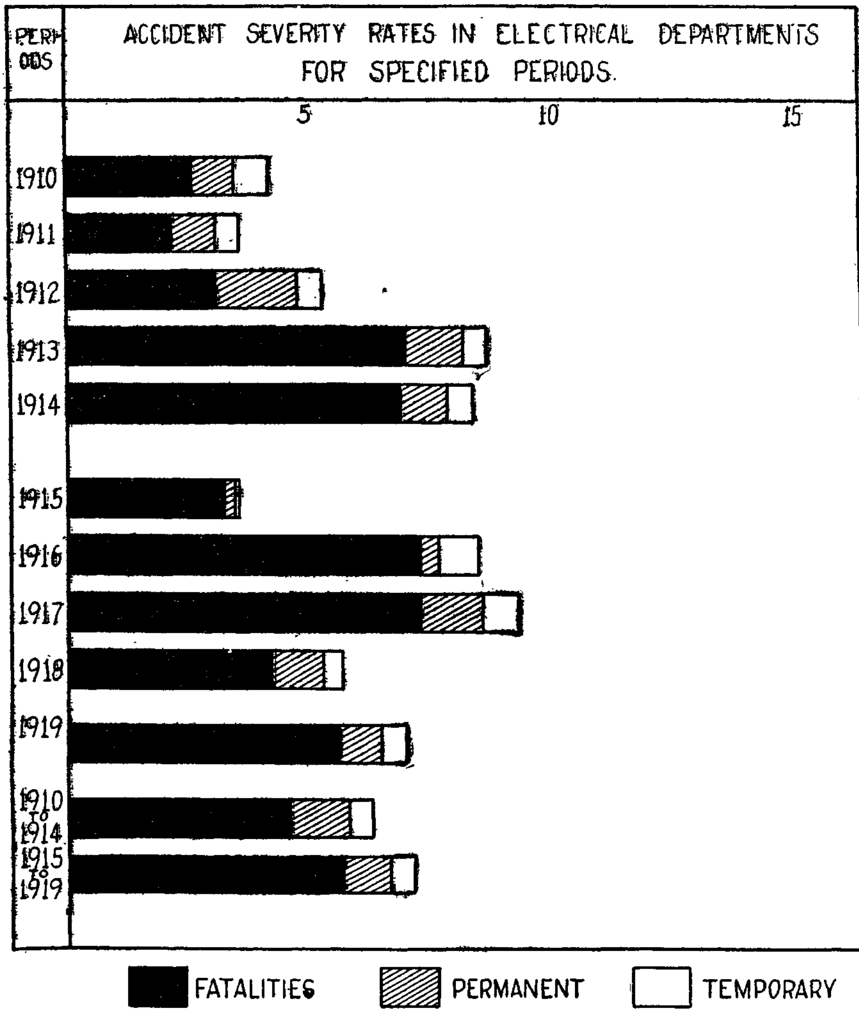
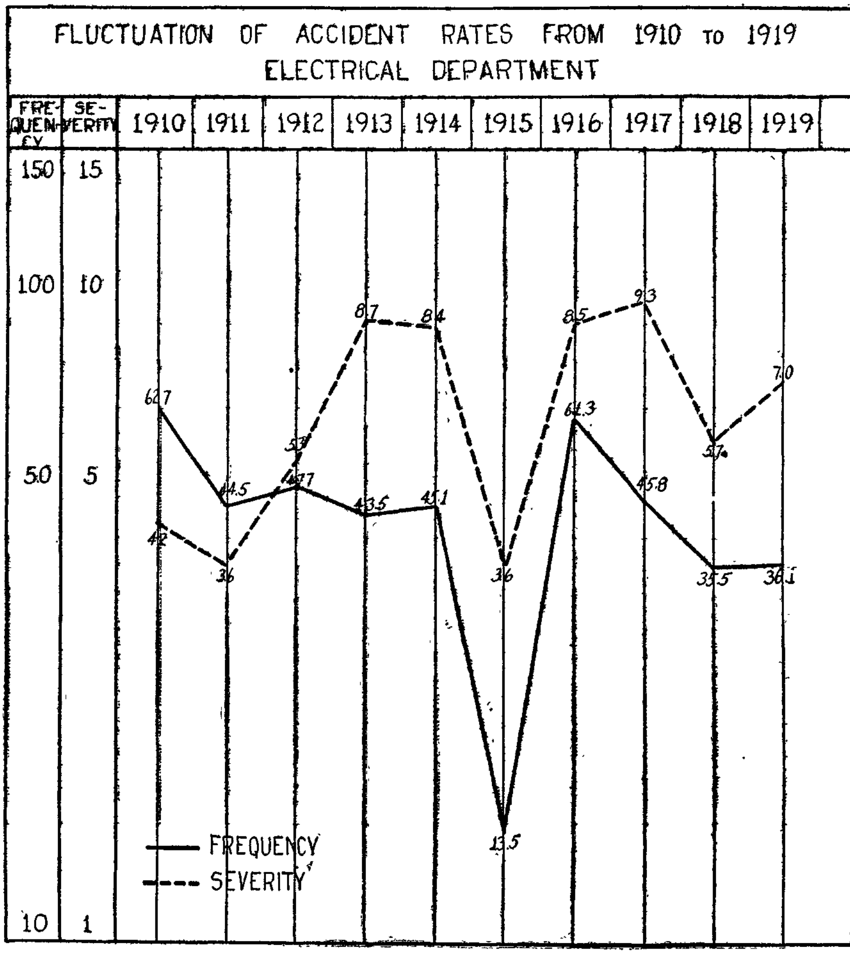

PERIODS
ACCIDENT SEVERITY RATES IN ELECTRICAL DEPARTMENTS FOR SPECIFIED PERIODS.
5
10
15
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 to 1914
1915 to 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 48.


FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
ELECTRICAL DEPARTMENT
FRE-QUEN-CY
SE-VERITY
1910 1911 1912 1913 1914 1915 1916 1917 1918 1919
150 15
100 10
50 5
10 1
62.7
44.5
47.7
43.5
45.1
13.5
64.3
45.8
35.5
36.1
4.2
3.6
5.3
8.7
8.4
3.6
8.5
9.3
5.7
7.0
FREQUENCY
SEVERITY

MECHANICAL DEPARTMENT.

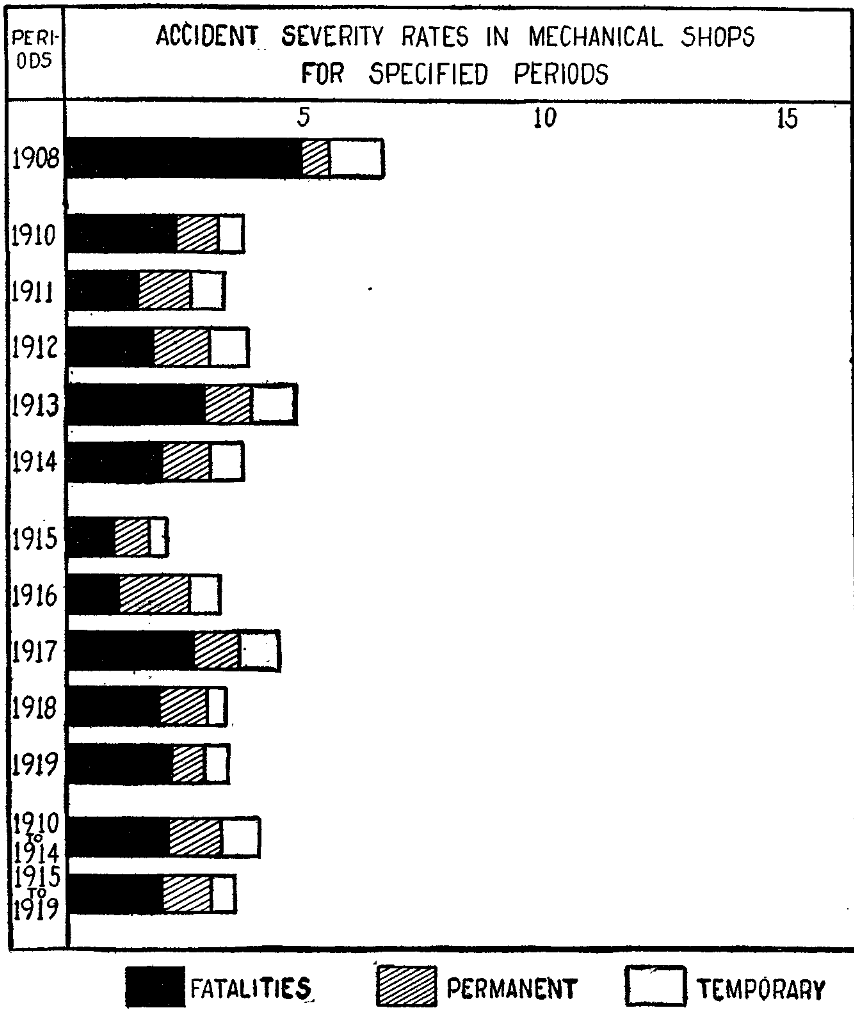
The mechanical department shows a definite improvement as to safety in the second 5-year period. It is not, however, as large as might have been expected. It is necessary repeatedly to recall the fact that this later period includes the war. To have come through that with a decrease instead of an increase is in itself an achievement.

The curves of the fluctuation chart run in this case an unusually parallel course. This indicates that specially severe injuries do not so frequently intrude with their disturbing influence as is the case in some of the departments.

TABLE 84.—ACCIDENT FREQUENCY AND SEVERITY RATES IN MECHANICAL DEPARTMENTS, 1908 TO 1920, BY YEARS AND PERIODS.

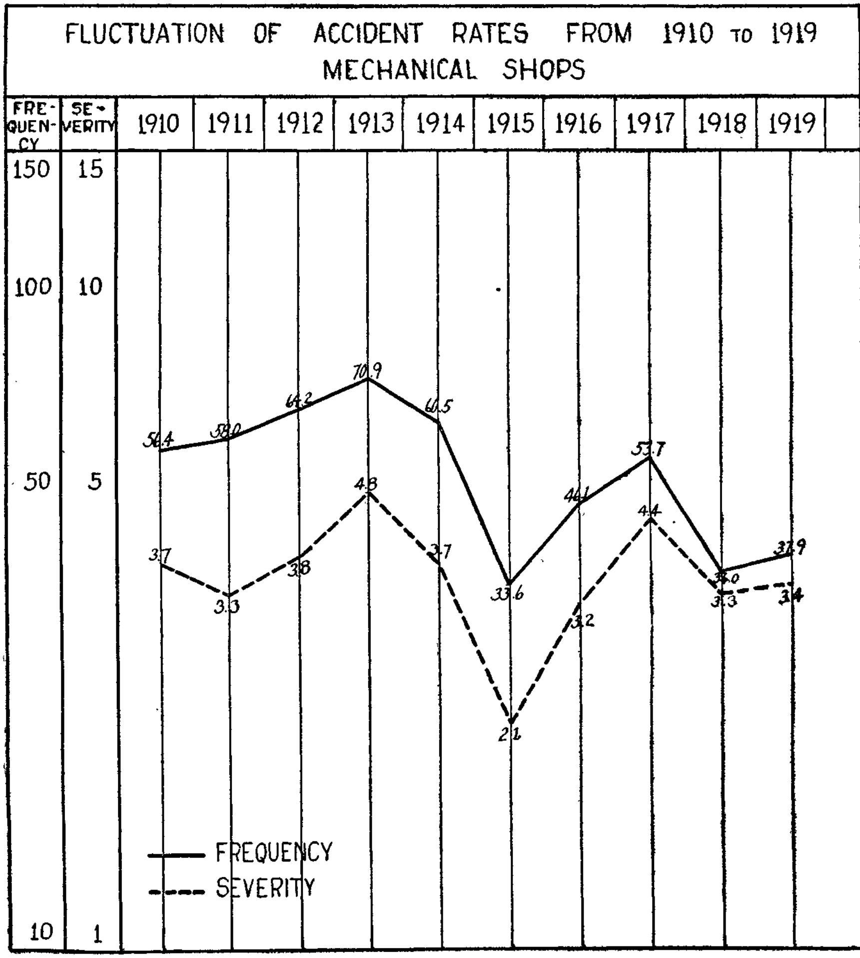
Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1908	1,619	4	7	430	441	0.8	1.4	89.1	91.3	4.9	0.6	1.1	6.6
1910	15,927	18	56	2,618	2,692	.4	1.2	54.8	56.4	2.3	.9	.5	3.7
1911	17,863	13	80	3,015	3,108	.2	1.5	56.3	58.0	1.5	1.1	.7	3.3
1912	21,591	19	95	4,040	4,154	.3	1.5	62.4	64.2	1.8	1.2	.8	3.8
1913	24,009	36	103	4,972	5,111	.5	1.4	69.0	70.9	2.9	1.0	.9	4.8
1914	17,772	18	60	3,149	3,227	.3	1.1	59.1	60.5	2.0	1.0	.7	3.7
1915	5,987	3	27	573	603	.2	1.5	31.9	33.6	1.0	.7	.4	2.1
1916	16,920	9	86	2,245	2,340	.2	1.7	44.2	46.1	1.1	1.5	.6	3.2
1917	33,328	43	134	5,201	5,378	.4	1.3	52.0	53.7	2.6	1.0	.8	4.4
1918	58,002	54	162	6,054	6,270	.3	.9	34.8	36.0	1.9	1.0	.4	3.3
1919	40,609	45	83	4,483	4,611	.4	.7	36.8	37.9	2.2	.7	.5	3.4
1920	34,648	26	68	3,767	3,861	.3	.7	36.2	37.2	1.5	.6	.5	2.6
1910 to 1914	97,161	104	392	17,794	18,292	.4	1.3	61.0	62.7	2.1	1.1	.8	4.0
1915 to 1919	154,846	154	492	18,556	19,202	.3	1.1	39.9	41.3	2.0	1.0	.5	3.5

CHART 49.



71087°—22——18

CHART 50.



POWER HOUSES.

Table 85 presents the trend of accident rates for power houses from 1915 to 1920.

TABLE 85.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR POWER HOUSES, 1917 TO 1920, BY YEARS, AND 1912 TO 1919, BY PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1917	4,552	7	7	210	224	0.5	0.5	15.4	16.4	3.1	1.0	0.3	4.4
1918	3,699	9	10	254	273	.8	.9	22.9	24.6	4.9	.5	.4	5.8
1919	4,093	11	2	213	226	.9	.2	17.3	18.4	5.4	.1	.2	5.7
1920	4,591	4	1	172	177	.3	.1	12.5	12.9	1.7	(1)	.2	1.9
1912 to 1914	8,083	6	21	544	571	.2	.9	22.4	23.5	1.5	.8	.3	2.6
1915 to 1919	13,219	27	21	739	787	.7	.5	18.6	19.8	4.1	.6	.3	5.0

1 Less than 0.05.

YARDS.

The yards department is an extraordinarily difficult one to deal with from the safety standpoint. Its salient feature is movement. Wherever there may be sudden approach at varying speeds accidents are likely to happen. The slight excess in the severity rates for the second 5-year period would have been much more pronounced had it not been for the fact that 1915 had no deaths.

On the whole it must be said that conditions in the internal transportation of the plants have shown no improvement since the earliest records were compiled. This is partly due to the fact that in many large plants the growth has gone beyond the available space and a condition of congestion prevails which can not be remedied without more drastic changes in arrangement than the management is as yet willing to undertake.

TABLE 86.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR YARDS, 1907 TO 1920, BY YEARS AND PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1907	2,618	5	10	509	524	0.6	1.2	64.8	66.6	3.8	2.6	1.1	7.5
1910	15,932	40	49	2,054	2,143	.8	1.0	43.0	44.8	5.0	1.0	.5	6.5
1911	9,085	11	43	1,336	1,390	.4	1.6	49.0	51.0	2.4	1.9	.7	5.0
1912	11,180	23	64	1,940	2,027	.7	1.9	57.8	60.4	4.1	1.4	.8	6.3
1913	11,859	28	50	1,807	1,885	.8	1.4	52.0	54.2	4.7	1.0	.7	6.4
1914	7,879	10	37	975	1,022	.4	1.6	41.2	43.2	2.5	1.4	.6	4.5
1915	3,843	....	15	417	432	....	1.3	36.2	37.5	....	1.0	.4	1.4
1916	7,853	12	56	929	997	.5	2.4	39.4	42.3	3.1	2.2	.6	5.9
1917	15,732	36	77	1,792	1,905	.8	1.6	38.0	40.4	4.6	1.7	.6	6.9
1918	16,354	33	62	1,526	1,621	.7	1.2	31.1	33.0	4.0	1.2	.6	5.8
1919	10,108	25	48	1,021	1,094	.8	1.6	33.7	36.1	4.9	1.9	.6	7.4
1920	12,087	10	33	922	965	.3	.9	25.4	26.6	1.7	1.3	.4	3.4
1910 to 1914	55,932	112	243	8,112	8,467	.7	1.5	48.6	50.8	4.0	1.4	.6	6.0
1915 to 1919	53,890	106	258	5,685	6,049	.7	1.6	35.2	37.5	3.9	1.6	.6	6.1

CHART 51.

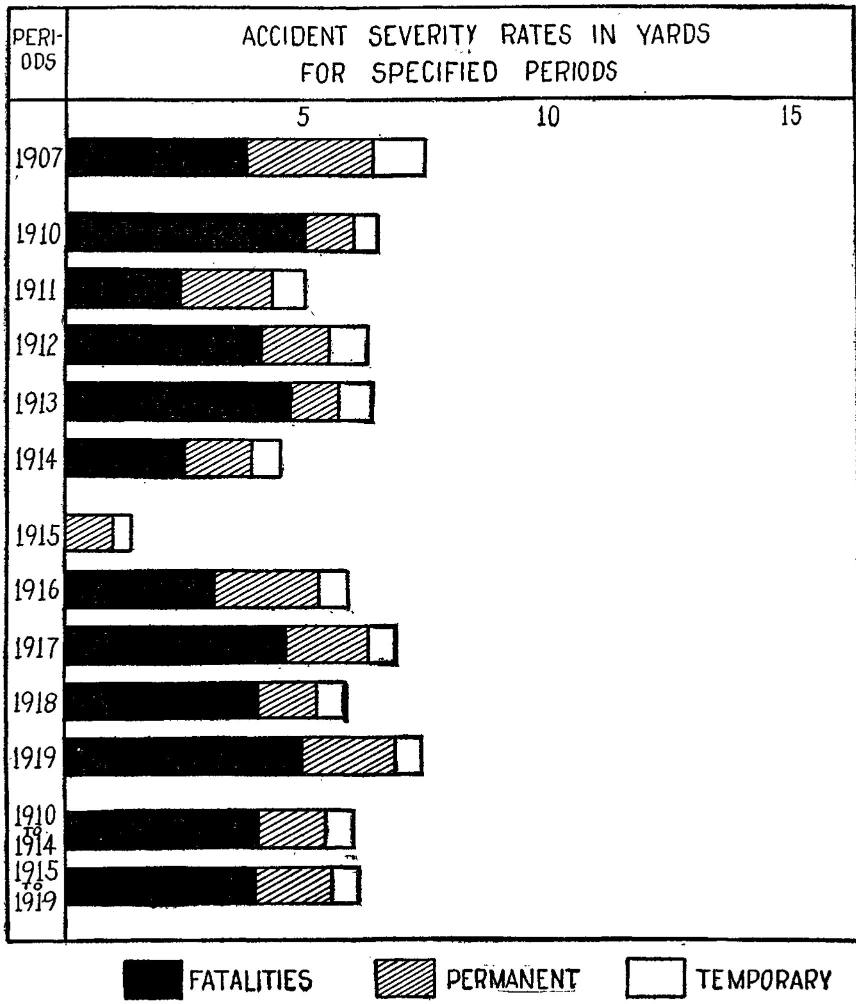
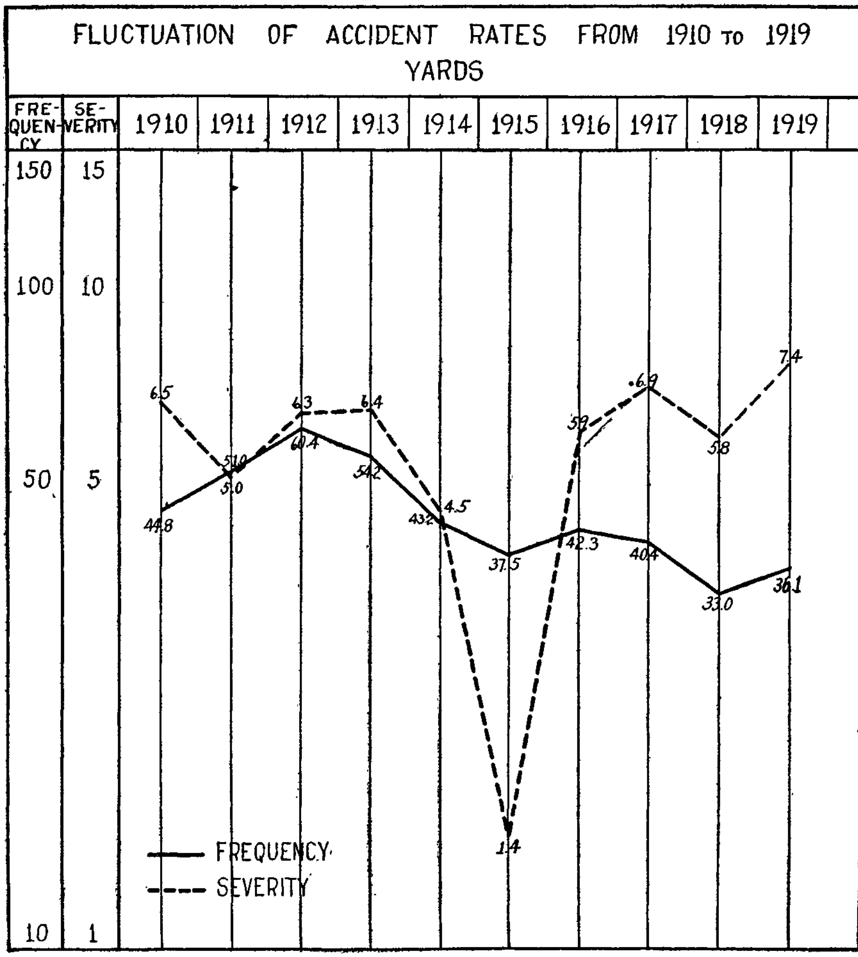

PERIODS
ACCIDENT SEVERITY RATES IN YARDS FOR SPECIFIED PERIODS
5
10
15
1907
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1910 to 1914
1915 to 1919
FATALITIES
PERMANENT
TEMPORARY

CHART 52.


FLUCTUATION OF ACCIDENT RATES FROM 1910 TO 1919
YARDS
FRE-QUEN-CY
SE-VERITY
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
150
15
100
10
50
5
10
1
6.5
44.8
51.0
5.0
6.3
60.4
6.4
54.2
4.5
43.2
37.5
1.4
5.9
42.3
6.9
40.4
5.8
33.0
7.4
36.1
FREQUENCY
SEVERITY

ERECTION OF STRUCTURAL STEEL.

In Table 87 are presented the accident frequency and severity rates for the erection of structural steel, from 1915 to 1920.

TABLE 87.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR STRUCTURAL STEEL ERECTION, 1915 TO 1920, BY YEARS, AND 1912 TO 1919 BY PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1915	803	8	7	251	266	3.3	2.9	104.2	110.4	19.9	4.3	1.2	25.4
1916	1,011	10	3	251	264	3.3	1.0	82.7	87.0	19.8	1.7	1.7	23.2
1917	1,156	12	15	442	469	3.5	4.3	127.5	135.3	20.8	4.0	2.2	27.0
1918	1,234	10	3	364	377	2.7	.8	98.3	101.8	16.2	2.0	1.4	19.6
1919	775	5	7	214	226	2.2	3.0	86.8	92.0	12.9	1.3	1.3	15.5
1920	637	6	12	204	222	3.3	6.6	111.8	121.7	19.7	3.7	2.5	25.9
1912 to 1914	2,157	26	24	738	788	4.0	3.7	114.0	121.7	24.1	5.5	1.8	31.4
1915 to 1919	4,979	45	35	1,522	1,602	3.0	2.3	101.9	107.2	18.1	2.6	1.6	22.3

It has long been known that this department was among the most hazardous in which men are occupied It probably has not been fully realized that it was the most hazardous of all. Consultation of Table 89 (p. 274) will show that in the severity of accidents only one department (docks and ore yards) exceeds the structural-steel erectors in any particular. The severity rate for permanent disability for docks and ore yards for 1915 to 1919 is 4.1 days per 1,000 hours' exposure, while erectors have 2.6 days. Since the exposure in docks and ore yards is rather small, the rates are less reliable than those for the larger departments.

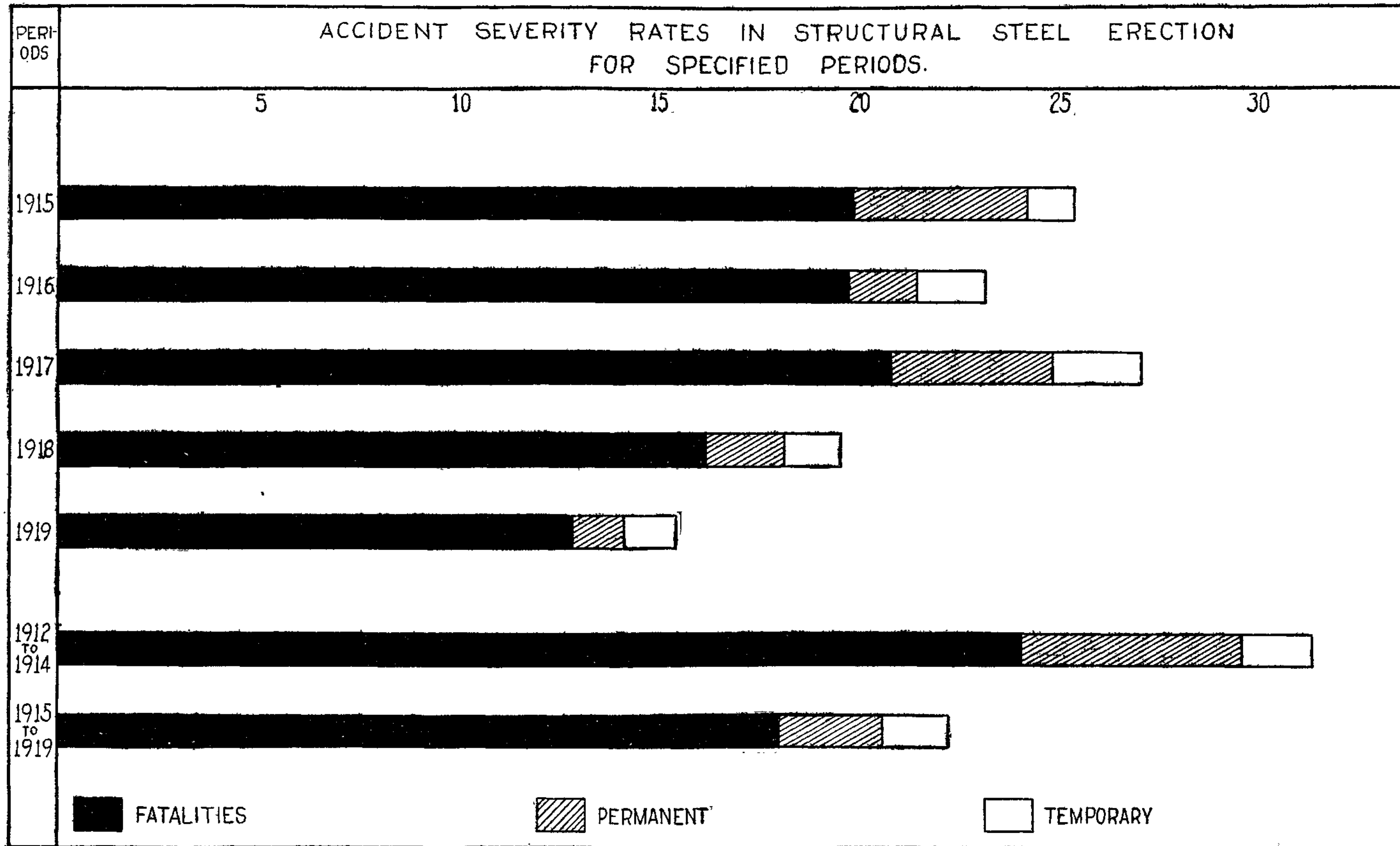
The erectors' severity from fatal injury of 18.1 days may be contrasted with the rate for brakemen in railway yards (16.6 days), road freight brakemen (14.1 days), electrical workers (5.7 days), and blast-furnace employees (4.7 days).

The five years ending with 1919 show a decided improvement when compared with the earlier period (22.3 days as against 31.4 days).

Two things are perfectly clear when these rates are considered: (1) Conditions in erecting are sufficiently serious to call for the most careful attention from those in charge; (2) the experience seems to indicate that much improvement is possible.

The inherent hazard of this occupation must be recognized as high. Added to this are some features which differentiate it from what may be termed fixed industry. Where all apparatus is necessarily portable it is much more difficult to apply adequate safeguards. All construction work is likely to be carried on under conditions of greater hurry and pressure than in ordinary manufacturing. Both contractor and owner are desirous of the earliest possible termination of the operation. Such conditions of haste do not make for safety. The temporary and migratory character of the business makes it more difficult to organize the working force along the lines which have proved successful in safety work in ordinary plants. It is clear, however, that these difficulties are not insurmountable. The same

CHART 53.


PERIODS
ACCIDENT SEVERITY RATES IN STRUCTURAL STEEL ERECTION FOR SPECIFIED PERIODS.
5
10
15
20
25
30
1915
1916
1917
1918
1919
1912 TO 1914
1915 TO 1919
FATALITIES
PERMANENT
TEMPORARY

principles that govern in fixed industry are applicable here, and the attention now being directed toward them by important construction firms should bring a further improvement in the near future.

The high rates prevalent in this occupation have often been ascribed to the reckless behavior of the men. This, like all such explanations, should be regarded with much skepticism. The poise with which one of these men works under conditions which would be impossible to a less experienced man is an evidence of his training rather than any willful disregard of his own safety. It has not been possible to make a critical study of the causes which are operative in this field such as has been made in some of the iron and steel departments, but such attention as it has been possible to give indicates very definitely that here, as elsewhere, there is great chance for the application of engineering skill in devising methods both safer and more efficient than those now in use.

MISCELLANEOUS DEPARTMENTS.

In Table 88 are given accident frequency and severity rates for 1915 to 1920 for the following miscellaneous departments: Coke ovens, armor-plate works, axle works, car wheels, docks and ore yards, woven-wire fence, nails and staples, and unclassified departments.

TABLE 88.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR MISCELLANEOUS DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1920, BY YEARS AND FOR SPECIFIED PERIODS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
COKE OVENS.													
1915	1,648	2	4	128	134	0.4	0.8	25.9	27.1	2.4	0.6	0.3	3.3
1916	2,195	5	6	150	161	.8	.9	22.7	24.4	4.6	.5	.4	5.5
1917	6,641	26	10	508	544	1.3	.5	25.5	27.3	7.8	.5	.4	8.7
1918	9,395	21	14	662	697	.7	.5	23.5	24.7	4.5	.5	.4	5.4
1919	9,022	12	10	647	669	.4	.4	23.9	24.7	2.7	.6	.4	3.7
1920	8,620	6	11	518	535	.2	.4	10.0	10.6	1.4	.7	.3	2.4
1912 to 1914	13,282	27	39	1,651	1,717	.7	1.0	41.4	43.1	4.1	1.5	.6	6.2
1915 to 1919	28,901	66	44	2,095	2,205	.8	.5	24.1	25.4	4.6	.5	.4	5.5
ARMOR-PLATE WORKS.													
1916	660	1	2	96	99	0.5	1.0	47.7	49.2	3.0	1.8	1.1	5.9
1917	1,438	4	2	225	231	.9	.5	52.2	53.6	5.6	.1	.9	6.6
1918	1,581	3	1	198	202	.6	.2	41.7	42.5	3.8	.1	.6	4.5
1919	1,082	1	......	186	187	.3	......	57.3	57.6	1.8	......	.8	2.6
1911 to 1914	3,000	4	12	362	378	.4	1.3	40.2	41.9	2.7	.5	.7	3.9
1916 to 1919	4,761	9	5	705	719	.6	.4	49.9	50.4	3.8	.3	.8	4.9
AXLE WORKS.													
1915	191	......	1	21	22	......	1.7	36.6	38.3	......	3.1	0.3	3.4
1916	372	......	......	17	17	......	......	15.2	15.2	......	......	.1	.1
1917	713	......	......	81	81	......	......	37.9	37.9	......	......	.9	.9
1918	609	......	3	156	159	......	1.6	85.4	87.0	......	3.9	1.1	5.0
1919	582	......	......	63	63	......	......	36.1	36.1	......	......	.7	.7
1920	743	......	......	100	100	......	......	44.8	44.8	......	......	.7	.7
1912 to 1914	1,326	2	4	438	444	0.5	1.0	110.1	111.6	3.0	2.1	1.6	6.7
1915 to 1919	2,467	......	4	338	342	......	.5	45.7	46.2	......	1.2	.7	1.9

TABLE 88.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR MISCELLANEOUS DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1920, BY YEARS AND FOR SPECIFIED PERIODS—Concluded.

CAR WHEELS.

Year or period.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.
1915	389	......	1	25	26	......	0.9	21.4	22.3	......	0.3	0.7	1.0
1916	734	2	2	348	352	0.9	.9	158.0	159.8	5.4	1.0	2.1	8.5
1917	1,296	3	4	250	257	.8	1.0	64.3	66.1	4.6	.4	.9	5.9
1918	1,866	1	......	337	338	.2	......	60.2	60.4	1.1	......	.6	1.7
1919	1,619	1	11	353	365	.2	2.3	72.6	75.1	1.2	1.0	1.0	3.2
1920	1,215	......	4	170	174	......	1.0	46.7	47.7	......	.9	.6	1.5
1912 to 1914	2,367	3	15	609	627	.4	2.1	85.8	88.3	2.5	.9	1.3	4.7
9115 to 1919	5,904	7	18	1,313	1,338	.4	1.0	74.1	75.5	2.4	.5	1.0	3.9

DOCKS AND ORE YARDS.

Year or period.	Number of workers.	Cases: Death.	Cases: Permanent disability.	Cases: Temporary disability.	Cases: Total.	Frequency: Death.	Frequency: Permanent disability.	Frequency: Temporary disability.	Frequency: Total.	Severity: Death.	Severity: Permanent disability.	Severity: Temporary disability.	Severity: Total.
1915	115	......	2	7	9	......	5.8	20.3	26.1	......	2.3	0.1	2.4
1916	195	3	2	16	21	5.1	3.4	27.4	35.9	30.8	7.3	.5	38.6
1917	353	2	1	78	81	1.9	.9	73.6	76.4	11.3	.7	1.0	13.0
1918	368	1	1	35	37	.9	.9	31.7	33.5	5.4	.3	.3	6.0
1919	352	......	6	39	45	......	5.7	37.0	42.7	......	10.4	.5	10.9
1920	379	1	2	12	15	.9	1.8	10.6	13.3	5.3	2.9	.1	8.3
1911 to 1914	1,293	3	11	139	153	.8	2.8	35.8	39.4	4.6	2.8	.8	8.2
1915 to 1919	1,383	6	12	175	193	1.4	2.9	42.2	46.5	8.7	4.1	.5	13.3

WOVEN-WIRE FENCE.

Year or period.	Number of workers.	Cases: Death.	Cases: Permanent disability.	Cases: Temporary disability.	Cases: Total.	Frequency: Death.	Frequency: Permanent disability.	Frequency: Temporary disability.	Frequency: Total.	Severity: Death.	Severity: Permanent disability.	Severity: Temporary disability.	Severity: Total.
1915	1,552	......	10	294	304	......	2.1	63.1	65.2	......	1.2	0.5	1.7
1916	1,623	......	18	180	198	......	3.7	37.0	40.7	......	3.0	.4	3.4
1917	1,269	......	10	98	108	......	2.6	25.7	28.3	......	2.1	.4	2.5
1918	1,531	......	5	77	82	......	1.1	16.8	17.9	......	1.0	.2	1.2
1919	1,336	1	4	35	40	0.2	1.0	8.7	9.9	1.5	.6	.2	2.3
1920	1,097	......	6	48	54	......	1.8	14.6	16.4	......	2.9	.2	3.1
1915 to 1919	7,311	1	47	684	732	.1	2.1	31.2	33.4	.3	1.6	.3	2.2

NAILS AND STAPLES.

Year or period.	Number of workers.	Cases: Death.	Cases: Permanent disability.	Cases: Temporary disability.	Cases: Total.	Frequency: Death.	Frequency: Permanent disability.	Frequency: Temporary disability.	Frequency: Total.	Severity: Death.	Severity: Permanent disability.	Severity: Temporary disability.	Severity: Total.
1915	1,546	1	12	181	194	0.2	2.6	39.0	41.8	1.3	1.7	0.3	3.3
1916	1,993	......	10	236	246	......	.2	39.5	39.7	......	1.0	1.4	2.4
1917	2,323	1	16	184	201	.1	2.3	26.4	28.8	.9	2.1	.3	3.3
1918	1,916	......	10	123	133	......	1.7	21.4	23.1	......	1.2	.2	1.4
1919	2,040	......	8	58	66	......	1.3	9.5	10.8	......	.5	.1	.6
1920	2,364	......	8	164	172	......	1.1	23.1	24.2	......	.8	.1	.9
1915 to 1919	9,818	2	56	782	840	.1	1.9	26.5	28.5	.4	1.3	.3	2.0

UNCLASSIFIED.

Year or period.	Number of workers.	Cases: Death.	Cases: Permanent disability.	Cases: Temporary disability.	Cases: Total.	Frequency: Death.	Frequency: Permanent disability.	Frequency: Temporary disability.	Frequency: Total.	Severity: Death.	Severity: Permanent disability.	Severity: Temporary disability.	Severity: Total.
1915	21,547	16	41	2,749	2,806	0.2	0.6	42.5	43.3	1.5	0.6	0.6	2.7
1916	24,216	17	72	2,714	2,803	.2	1.0	37.4	38.6	1.4	1.4	.6	3.4
1917	71,249	65	164	8,165	8,394	.3	.8	38.2	39.3	1.8	.8	.5	3.1
1918	97,513	79	284	9,930	10,293	.3	1.0	33.9	35.2	1.6	.9	.5	2.9
1919	78,804	60	145	7,054	7,259	.3	.6	29.8	30.7	1.5	.7	.4	2.6
1920	104,741	72	261	11,208	11,541	.2	.8	35.7	36.7	1.4	.9	.5	2.8
1915 to 1919	293,329	237	706	30,612	31,555	.3	.8	34.8	35.9	1.6	1.3	.5	3.4

A NEW STANDARD OF COMPARISON.

In Bulletin No. 234 the suggestion was made that the period of five years from 1910 to 1914 afforded a sufficient exposure to be regarded as typical of the industry and the departments composing it. It afforded, therefore, a fair standard by which to measure the success of the safety movement, since it covered a period in which the efforts for safety had become somewhat standardized and in which time had been afforded for them to exercise a reasonable amount of influence.

With the intrusion of the great war it would not have been greatly surprising if conditions had arisen much less satisfactory than those of the earlier period. Fortunately, the safety movement had become sufficiently strong so that not only did it prevent serious increase of rates but on the whole it was able materially to lower them. It is proper, therefore, to insist that the experience of 1915 to 1919 should now be regarded as a representative standard by which the various departments may test their progress. Lower rates than those of that period represent progress, higher rates misfortune or disgrace. Either condition ought to be the basis for continued effort which should in the next five years set a still higher standard.

TABLE 89.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR THE IRON AND STEEL INDUSTRY FOR THE 5-YEAR PERIOD 1915 TO 1919.

Department.	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total
Blast furnaces	136,166	317	312	15,287	15,916	0.8	0.8	37.4	39.0	4.7	0.9	0.5	6.1
Bessemer	25,645	62	112	4,262	4,436	.8	1.5	55.4	57.7	4.8	1.1	1.0	6.9
Open hearths	86,175	191	317	12,563	13,071	.7	1.2	48.6	50.5	4.4	1.2	.9	6.5
Crucible	4,647	2	13	766	781	.1	.9	54.9	55.9	.9	1.0	.8	2.7
Foundries	92,746	84	277	16,604	16,965	.3	1.0	59.7	61.0	1.8	.9	.7	3.4
Bar mills	24,081	20	77	4,745	4,842	.3	1.1	65.6	67.0	1.7	.7	.7	3.1
Heavy rolling mills	75,166	91	275	6,950	7,316	.4	1.2	30.8	32.4	2.4	1.0	.5	3.9
Plate mills	35,073	25	89	4,016	4,130	.2	.8	38.2	39.2	1.4	.6	.5	2.5
Puddling mills	8,460	4	15	1,082	1,101	.2	.6	42.6	43.4	.9	.4	.6	1.9
Rod mills	15,218	14	70	1,721	1,805	.3	1.5	37.7	39.5	1.8	1.3	.5	3.6
Sheet mills	104,335	37	172	10,034	10,243	.1	.5	32.1	32.7	.7	.4	.4	1.5
Tube mills	75,108	38	178	4,825	5,041	.2	.8	21.4	22.4	1.0	.5	.3	1.8
Miscellaneous rolling mills	102,696	53	218	12,644	12,915	.2	.7	41.0	41.9	1.0	.5	.6	2.1
Fabricating	80,985	59	163	13,195	13,417	.2	.7	54.3	55.2	1.5	.5	.6	2.6
Forge shops	12,667	9	45	2,189	2,243	.2	1.2	57.6	59.0	1.4	1.1	.9	3.4
Wire drawing	52,666	12	321	6,912	7,245	.1	2.0	43.7	45.8	.5	1.6	.5	2.6
Electrical	16,023	46	40	1,851	1,937	1.0	.8	38.5	40.3	5.7	1.0	.5	7.2
Mechanical	154,846	154	492	18,556	19,202	.3	1.1	39.9	41.3	2.0	1.0	.5	3.5
Power houses	13,219	27	21	739	787	.7	.5	18.6	19.9	4.1	.6	.3	5.0
Yards	53,890	106	258	5,685	6,049	.7	1.6	35.2	37.5	3.9	1.6	.6	6.1
Structural steel erection	4,979	45	35	1,522	1,602	3.0	2.3	101.9	107.2	18.1	2.6	1.6	22.3
Coke ovens	29,901	66	44	2,095	2,205	.8	.5	24.1	25.4	4.6	.5	.4	5.5
Armor plate	4,761	9	5	705	719	.6	.4	49.9	50.4	3.8	.3	.8	4.9
Axle works	2,467	......	4	338	342	......	.5	45.7	46.2	......	1.2	.7	1.9
Car wheels	5,904	7	18	1,313	1,338	.4	1.0	74.1	75.5	2.4	.5	1.0	3.9
Docks and ore yards	1,383	6	12	175	193	1.4	2.9	42.2	46.5	8.7	4.1	.5	13.3
Wire fence	7,311	1	47	684	732	.1	2.1	31.2	33.4	.3	1.6	.3	2.2
Nails and staples	9,818	2	56	782	840	.1	1.9	26.5	28.5	.4	1.3	.3	2.0
Unclassified	293,329	237	706	30,612	31,555	.3	.8	34.8	35.9	1.6	1.3	.5	3.4

CHAPTER X.—ACCIDENT RATES AND THE WAR.

For a very long time to come the question of the influence of the World War upon our social and industrial life will be a subject of earnest debate. It is accordingly appropriate to devote a chapter of this bulletin to presenting some illustrations which seem most clearly to indicate the result upon accident rates which war conditions have tended to produce.

BASIC DEPARTMENTS OF THE INDUSTRY.

The first case to be considered is that of a group of mills which have been combined because they afford opportunity both to determine severity rates and to examine the movement in considerable detail. These mills are largely devoted to the fundamental departments of the industry, namely, blast furnaces, steel works, and rolling mills. They employed in the years covered (1914 to 1919) men varying in number from 35,000 to 50,000. The size of the group is accordingly sufficient to assume that the results obtained are fairly typical.

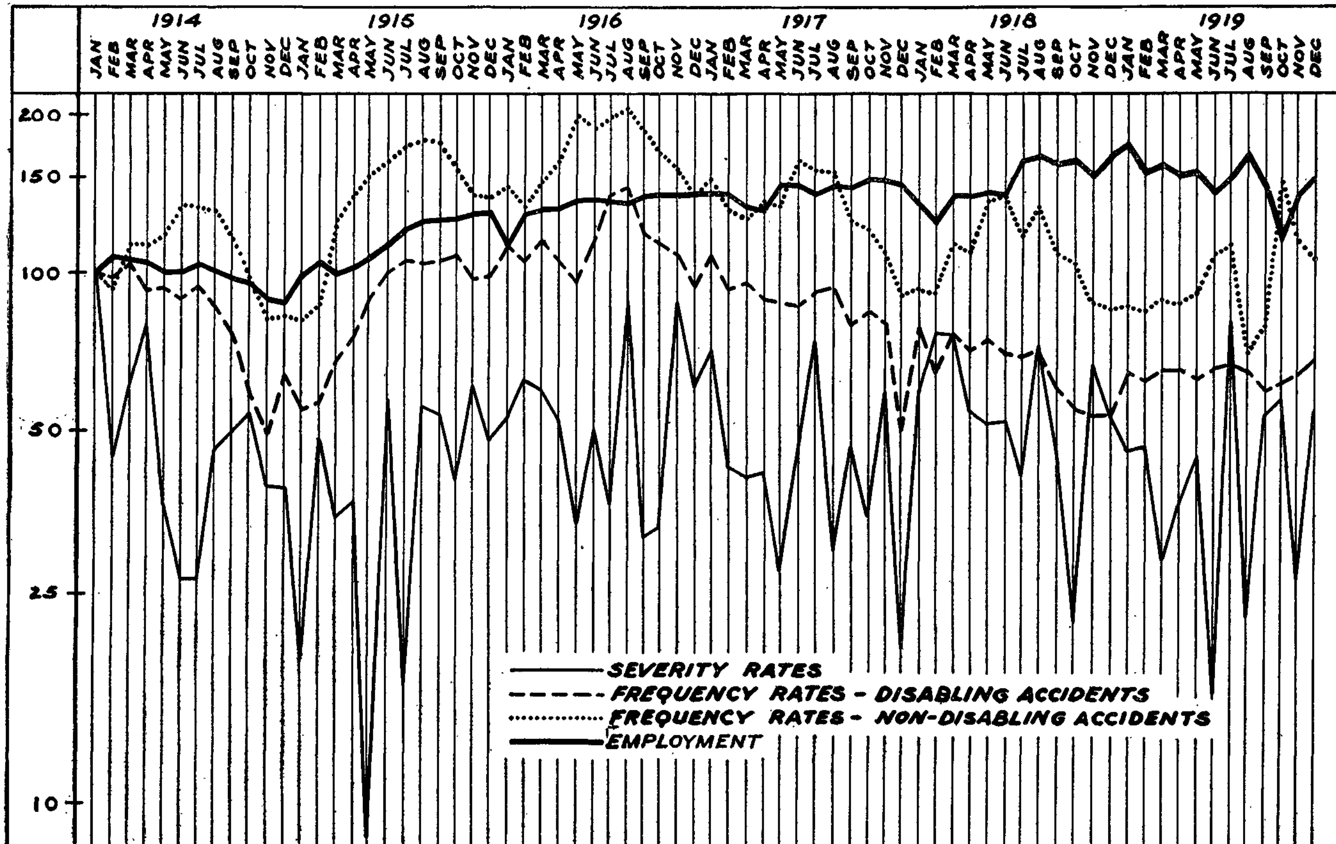
Chart 54 will first be considered, in which are shown from month to month over the six years the fluctuations of four items, namely, employment, frequency of nondisabling accident, frequency of disabling accident, and severity of disabling accident. The figures of each group are reduced to index numbers on the basis of January, 1914, as 100. They are then plotted on a percentage scale which shows the per cent of increase or decrease from month to month.

It is desirable before proceeding with discussion of the features of this chart to emphasize one point which is brought out by it. That is the accidental character of accidents. Even in a group of employees as large as the present one, it will be found that general conclusions which seem to be fully warranted are flatly contradicted by a great number of special cases. Accidents in their very nature depend on combinations of circumstances which might never occur twice. It is the unexpected which gives character to accidental happenings. This is true in some measure of all types of accidents, but particularly is it true of those which involve death or serious injury. It should be expected therefore that just such fluctuations as those recorded between the months would occur. The fact that there is not the same regularity as that found in other statistical fields does not in the least imply imperfection in the basic data nor error in the treatment.

If employment be considered, it will become evident that it was fairly constant during the first eight months of 1914. It is known from other sources of information that this was at a considerably lower level than for the year 1913, which was a year of particularly high activity in the industry. There is then a further decline from which recovery begins with 1915. This increase continues with some unsteadiness until a maximum is reached in the month of January, 1919. From that point there is a general tendency to decline.

Turning now to nondisabling accidents, it will appear that while they are doubtless influenced by the changes in employment they are

CHART 54.—FLUCTUATION FROM MONTH TO MONTH OF SEVERITY RATES, OF FREQUENCY RATES, AND OF EMPLOYMENT, 1914 TO 1919.



more responsive to other and more obscure factors. When employment is at the lowest point this class of accidents is also at a low point. From January, 1915, there is an irregular rise, more rapid than the rise in employment, until August, 1916, from which there is a decline with some upward movements in each year.

The frequency of disabling accidents runs a somewhat similar course but nowhere departs so widely from the level of January, 1914, as do nondisabling accidents. The high month is August, 1916, from which point there is an irregular decline.

The severity of disabling accidents is much more irregular from month to month and nowhere reaches a level as high as that of January, 1914. The high months are August, 1916, February, March, and August, 1918, and July, 1919. This irregularity and the frequent departure from the showing regarding frequency are entirely normal in view of the fact that the comparatively small number of deaths have a controlling influence on severity rates and the deaths are not distributed regularly.

Chart 54 shows the percentage variations which occur from month to month. It is desirable to present the same data in a form in which the irregularities are "smoothed" and the general trend of events made evident without the confusion due to temporary conditions. In Chart 55 the rates were calculated for the years ending with each month, beginning with December, 1914. Each point in the curves resulting from plotting these values therefore represents an entire year and the irregularities seen in Chart 54 are in a measure eliminated.

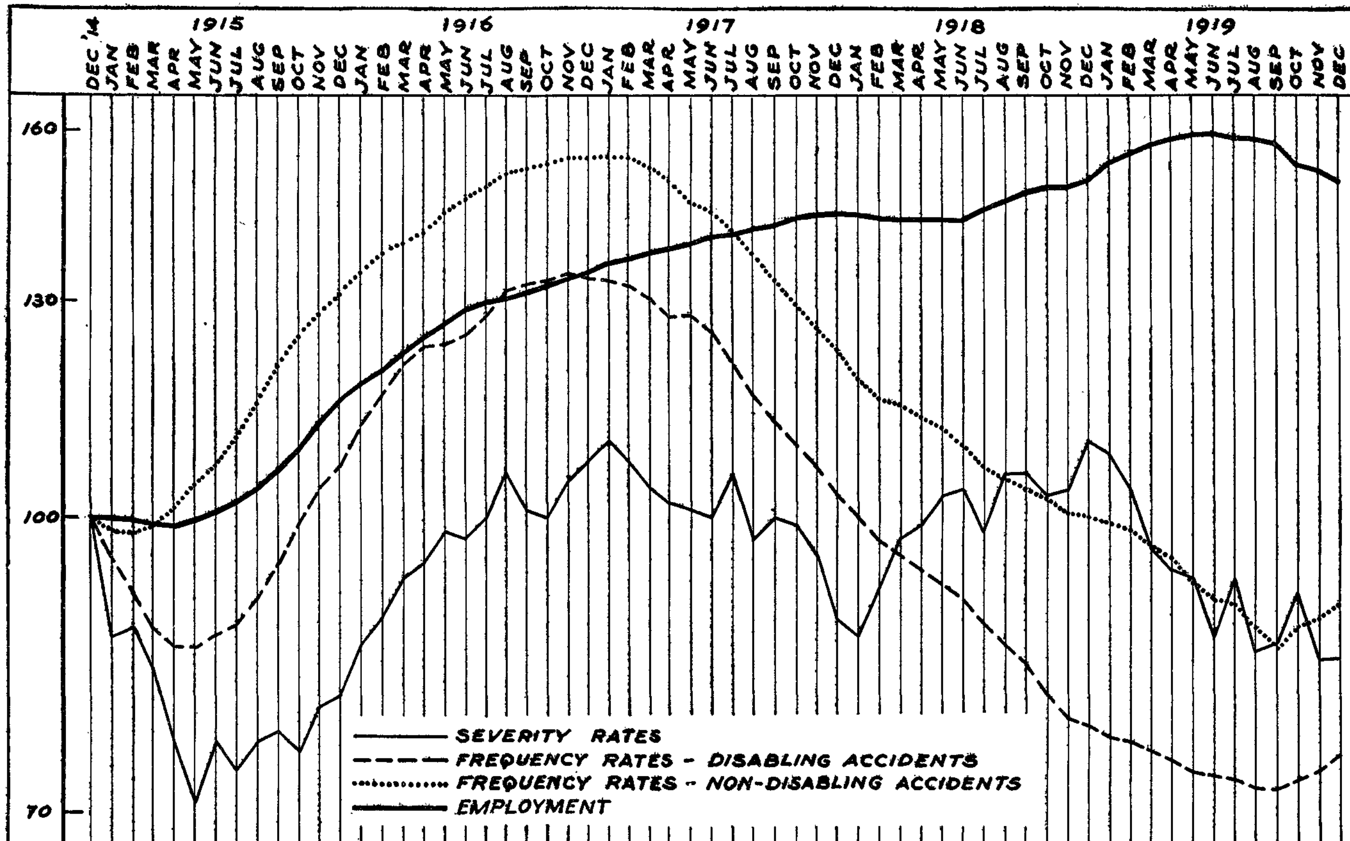
A study of Chart 55 reveals that there was a slight downward trend in employment during the early portion accompanied by downward movements in each of the three accident curves. This was most pronounced in severity of disabling accident, less so in frequency of disabling cases, and least in nondisabling cases.

Then, from the year ending June, 1915, to that ending June, 1916, employment was rapidly increasing. Each of the accident curves rises with the employment curve, the three pursuing nearly parallel courses, and both frequency curves rising more rapidly than the employment curve. It is known from other study of the situation that this upward movement in employment involved a high accession rate of men new to the business. The huge demand for steel which came with the opening of the war led to taking on any man who offered himself and seemed equal to the physical demands of the task. Such a high accession rate of inexperienced men is always accompanied by increasing accident rates.

From the year ending June, 1916, to that ending January, 1917, the rise in employment continued, but at a less rapid rate. The proportion of inexperienced men introduced is known to have been markedly less. The accident curves rise to this point but show the influence of the slackening in accessions. From the year ending January, 1917, the employment curve continues to rise quite steadily but the accident curves begin to decline. In the case of nondisabling and disabling frequency this decline continues to the calendar year 1919.

In the severity curve there appears a striking disagreement with the trend of frequency. While frequency is falling from the year ending January, 1918, severity rises to the year ending December,

CHART 55.—TREND OF SEVERITY RATES, OF FREQUENCY RATES FOR DISABLING AND NONDISABLING ACCIDENTS, AND OF EMPLOYMENT, 1914 TO 1919.



1918. From that point irregular decline occurs to the year ending December, 1919.

Chart 54 attempts to present the fluctuations from month to month and Chart 55 the general trend over the six years. With this picture in mind it is possible to consider the relations of these several curves to war conditions and to suggest some explanations of the phenomena.

It may first be noted that the records embodied in the charts do not go back quite far enough to give all the desirable information. Periods of high industrial activity are necessarily those in which accident rates will tend to rise. During the period from 1906 onward there have been three conspicuous periods of this kind. They are approximately 1906–1907, 1912–1913, 1916–1918. The death rates, per 1,000,000 hours worked in the mills under consideration for the years since 1910 are as follows: 1910, 0.70; 1911, 0.60; 1912, 0.63; 1913, 0.67; 1914, 0.47; 1915, 0.37; 1916, 0.50; 1917, 0.40; 1918, 0.53; 1919, 0.40. It will be observed that these figures have high points in 1910, 1913, and 1918, with depressed intervals between. The important point to be noted is that the prewar high point of 1913 is higher than the war high point of 1918, in the proportion of 67 to 53. That is to say, the tendency to rising rates which war conditions brought about either was opposed by more effective safety measures or was intrinsically less than that existing in the prewar period. It may fairly be urged that the explanation is to be found to a considerable degree in the improved construction of the new buildings and machinery which were installed in response to the war demand and in the active efforts put forth in training and introducing the new men who had to be employed.

A considerable number of industrial concerns took the position that the demands of war production were so imperative that they were perfectly justified in relaxing attention to safety measures of all sorts. The result is reflected in the increased accident occurrence registered by many agencies. Whether or not this increase brought the rates generally above the prewar standard is a matter which can not be determined with certainty. It is to the great and lasting credit of the iron and steel industry that it did meet the situation directly and endeavored to combat the inevitable tendency by increased efforts. The outcome of these various efforts was first to check the rising accident rates and finally to bring them down to points lower than the prewar level.

It is now pertinent to examine the contradiction noted above between the indications afforded by the frequency rates and severity rates for the years ending in the months of 1918. In this portion of the charts, frequency rates both for disabling and nondisabling accidents show a tendency to decline while severity is rising. This condition is of interest from several standpoints. It has often been noted that frequency and severity rates give these opposite indications; indeed, this fact was the moving reason for working out the system of severity rates. It is not often, however, that the contradiction is as pronounced and long continued as in this case. It is clear that the efforts of one sort and another which kept severity below the rate of 1913 and produced a marked decline of frequency after 1916 were after all not so well adapted to meet the severity problem as they were to deal with the problem of minor injury.

Severity, it is true, did decline for a time concurrently with frequency but it then took a turn in the opposite direction, which continued until the close of the calendar year 1918. From that point the curve again concurs with those of frequency. The extent to which minor injury was controlled in 1918 and the failure equally well to control the severer forms are strikingly brought out by contrasting the years 1915 and 1918, as is done in Table 90.

TABLE 90.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR A GROUP OF MILLS IN THE IRON AND STEEL INDUSTRY, 1915 AND 1918, BY MONTHS.

Month.	Frequency rates (per 1,000,000 hours' exposure).		Severity rates (per 1,000 hours' exposure).		Month.	Frequency rates (per 1,000,000 hours' exposure).		Severity rates (per 1,000 hours' exposure).	
	1915	1918	1915	1918		1915	1918	1915	1918
January	32.4	45.7	1.4	4.5	August	61.5	41.6	4.2	5.3
February	33.3	37.8	3.6	5.6	September	62.1	35.7	4.0	3.4
March	39.7	44.6	2.6	5.6	October	63.9	32.5	3.0	1.9
April	44.1	41.5	2.8	4.1	November	57.3	31.6	4.5	5.0
May	53.3	43.5	.6	3.9	December	57.8	31.5	3.6	4.0
June	59.3	41.0	4.3	3.9					
July	62.7	40.5	1.2	3.1	Total	53.2	38.8	3.0	4.1

Inspection of this table will disclose that 9 of the 12 months of 1915 have higher frequency rates than the same months of 1918. On the contrary 1918 shows higher severity in 9 of the 12 months. Evidently the conditions of the two years were in some way distinctly different. Superficially the differences appear to be that 1915 was a year of rapid changes in the working force and that 1918 was one of relative stability of the workers but of intense industrial activity. In the first condition it is clear that all accident rates tend to rise rapidly. It is the uniform experience that whenever the accession of inexperienced men is increasing the accident rates tend strongly to go up and will do so unless very rigorous measures are taken in opposition.

A reasonable explanation of the rising severity of the years ending in 1918 is much less easy. The greater industrial activity of that year must have had its influence, but knowledge of the plants does not seem to justify placing any great stress upon that factor. The operations of such mills as are here grouped are necessarily of a rather leisurely character and can not in the nature of the case be hurried sufficiently to increase greatly the hazard of the individual man.

It has been suggested that the "flu" epidemic may have so influenced the physical condition of the men that they were more liable to accidental injury. This can scarcely be given great weight since, though the severity rate for the months when flu was most prevalent is higher than the average, it is not higher than that for several other groups of months in which there was no flu complication.

It would appear that this is another case where the operators of the mills were led into a mistaken sense of security by the steadily falling frequency rates and so did not maintain full and rigorous attention to the causes of more severe injury. At all events, it may be said that without constant attention to the severity rate it is impossible to have an accurate idea of the conditions which must be met.

The rates which form the basis of the foregoing charts and discussion are given in Tables 91 and 92.

TABLE 91.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR A GROUP OF MILLS IN THE IRON AND STEEL INDUSTRY, 1914 TO 1919, BY MONTHS.

Month.	1914	1915	1916	1917	1918	1919
	Frequency rates for nondisabling accidents (per 1,000,000 hours' exposure).					
January	203	164	293	306	189	175
February	190	178	268	265	186	171
March	229	252	300	254	232	182
April	228	281	329	272	223	178
May	239	309	404	303	276	186
June	270	327	381	332	281	220
July	267	349	404	317	238	230
August	263	360	418	311	269	141
September	234	358	377	254	221	157
October	199	317	341	244	211	302
November	165	281	315	223	177	234
December	167	279	285	185	173	215
Total	222	292	343	272	223	203
	Frequency rates for disabling accidents (per 1,000,000 hours' exposure).					
January	59.0	32.4	66.4	63.8	45.7	37.9
February	57.7	33.3	62.0	54.9	37.8	36.5
March	61.3	39.7	67.2	56.3	44.6	38.1
April	54.5	44.1	62.1	52.9	41.5	38.0
May	54.9	53.3	56 5	51.7	43.5	37.0
June	53.0	59.3	67.0	50.8	41.0	38.5
July	55.6	62.7	81.7	54.6	40.5	39.0
August	51.1	61.5	84.7	55.5	41.6	37.9
September	44.4	62.1	69.7	46.5	35.7	35.2
October	34.9	63.9	66.7	49.6	32.5	36.2
November	29.4	57.3	63.1	46.6	31.6	37.3
December	37.5	57.8	55.8	35.6	31.5	39.9
Total	50.0	53.2	66.9	51.5	38.8	37.7
	Severity rates for disabling accidents (per 1,000 hours' exposure).					
January	7.5	1.4	3.9	5.3	4.5	3.5
February	3.4	3.6	4.6	3.2	5.6	3.5
March	4.6	2.6	4.5	3.1	5.6	2.2
April	5.9	2.8	3.9	3.2	4.1	2.7
May	2.7	.6	2.5	2.1	3.9	3.4
June	2.0	4.3	3.7	3.5	3.9	1.2
July	2.0	1.2	2.7	5.5	3.1	6.0
August	3.5	4.2	6.5	2.2	5.3	1.7
September	3.7	4.0	2.4	3.5	3.4	4.0
October	4.0	3.0	2.5	2.6	1.9	4.3
November	3.0	4.5	6.6	4.4	5.0	2.0
December	2.9	3.6	4.5	1.5	4.0	4.1
Total	3.8	3.0	4.0	3.3	4.1	3.2

71087°—22——19

TABLE 92.—ACCIDENT FREQUENCY AND SEVERITY RATES FOR A GROUP OF MILLS IN THE IRON AND STEEL INDUSTRY, 1914 TO 1919, BY YEARS ENDING WITH EACH MONTH.

Year ending with—	1914	1915	1916	1917	1918	1919
	Frequency rates for nondisabling accidents (per 1,000,000 hours' exposure).					
January	....	219	299	344	263	221
February	....	218	307	343	256	219
March	....	220	310	339	255	215
April	....	225	314	334	251	211
May	....	231	322	326	248	205
June	....	237	327	322	243	201
July	....	245	332	315	236	200
August	....	255	337	306	233	195
September	....	267	339	296	230	189
October	....	277	341	288	227	195
November	....	285	343	280	223	196
December	222	292	343	272	223	200
	Frequency rates for disabling accidents (per 1,000,000 hours' exposure).					
January	....	47.8	55.8	66.7	50.0	38.2
February	....	45.6	58.0	66.1	48.6	38.0
March	....	43.7	60.1	65.2	47.7	37.6
April	....	42.7	61.4	63.7	46.8	37.3
May	....	42.7	61.5	63.9	46.1	36.7
June	....	43.4	62.2	62.5	45.2	36.5
July	....	44.2	63.8	60.3	44.0	36.3
August	....	45.4	65.8	58.0	42.8	36.0
September	....	47.1	66.4	56.1	41.8	35.9
October	....	49.6	66.7	54.6	40.3	36.3
November	....	51.7	67.2	53.2	39.1	36.7
December	50.0	53.2	66.9	51.5	38.8	37.5
	Severity rates for disabling accidents (per 1,000 hours' exposure).					
January	....	3.3	3.2	4.1	3.3	4.1
February	....	3.3	3.3	4.0	3.5	3.9
March	....	3.1	3.5	3.9	3.7	3.6
April	....	2.9	3.6	3.8	3.7	3.5
May	....	2.7	3.7	3.8	3.9	3.5
June	....	2.9	3.7	3.8	3.9	3.3
July	....	2.8	3.8	4.0	3.7	3.5
August	....	2.9	4.0	3.7	4.0	3.2
September	....	2.9	3.8	3.8	4.0	3.2
October	....	2.8	3.8	3.7	3.9	3.4
November	....	3.0	3.9	3.6	3.9	3.2
December	3.8	3.5	4.0	3.3	4.1	3.2

DEPARTMENTS OF THE INDUSTRY MANUFACTURING VARIOUS PRODUCTS.

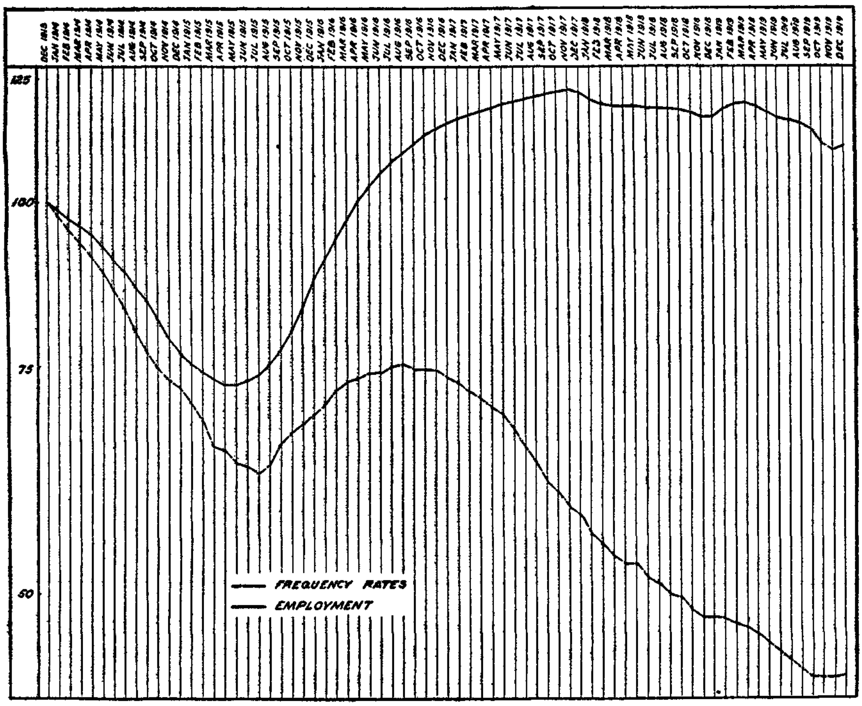
The foregoing discussion illustrates the trend of accident rates in the basic departments of the industry. It will be of interest to determine whether the same forces were at work in other departments and to what extent the results were the same.

The plants for which it is possible to follow the details of war-time experience employed during the 7 years which are covered a number of men varying from 110,000 to 186,000. The groups forming this total, which will be analyzed in seeking to determine the war-time experience in manufacturing various products, are sufficiently large to afford reasonable confidence that they represent typical conditions.

Chart 56 exhibits the trend of employment and of accident frequency rates in the entire group of plants from the year ending

December, 1913, to that ending December, 1919. The year 1913, as before noted, was one of high industrial activity. Both in that particular and in the matter of accident rates the year formed a peak in the curves. Following 1913 employment declined to the year ending May, 1915, and accident rates to the year ending July, 1915. Employment was increasing from that year until that ending November, 1917. A decline then began which was still in progress in the year ending December, 1919. Accident frequency increased from the year ending July, 1915, to the year ending September, 1916, and then while employment was still rising began to decline and con-

CHART 56.—TREND OF FREQUENCY RATES AND OF EMPLOYMENT IN THE IRON AND STEEL INDUSTRY, 1913 TO 1919.

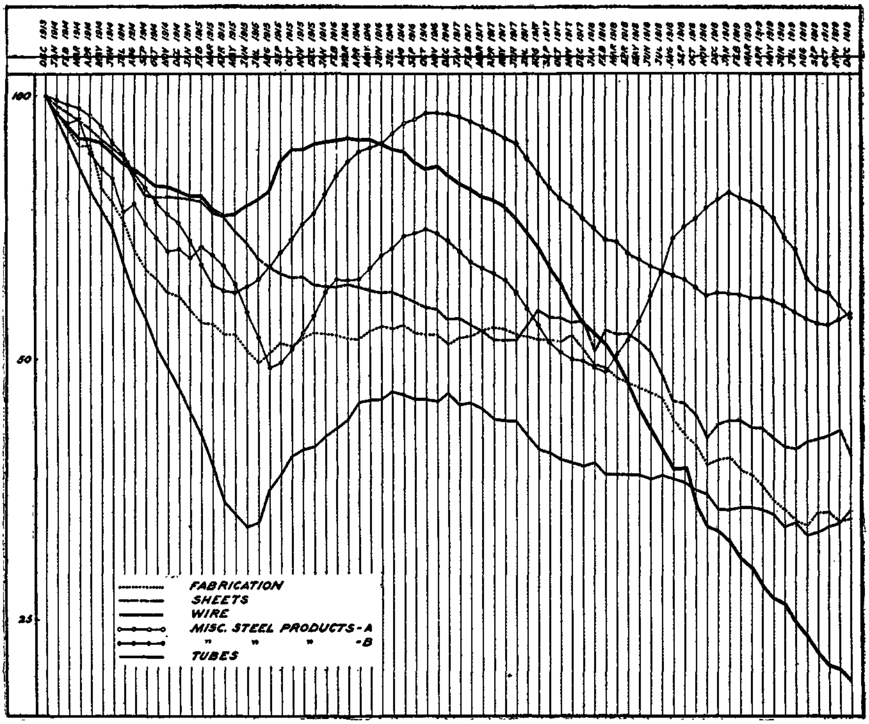


tinued so to do to the year ending December, 1919. It will be seen that this was in substantial agreement with what happened in the smaller group already considered.

The component parts of this total are presented in Chart 57. It presents two groups of mills which produce miscellaneous steel products and one group each of mills producing sheets and tin plate, wire products, tubes, and fabricated products.

Five of the six show a declining accident frequency to a year ending in some month about the middle of 1915. The sheet mills are unique among these production groups in that they show a declining accident frequency with only minor irregularities from the year ending December, 1913, to the year ending December, 1919. The other five groups have a rising frequency rate from a year ending near the middle of 1915 to a year ending with some month in 1916, varying from March to December. From that point there is a continuous, though not perfectly regular, decline to the year ending

CHART 57.—TREND OF FREQUENCY RATES IN THE MANUFACTURE OF SPECIFIED PRODUCTS, 1913 TO 1919.



December, 1919, except in one case. One of the two groups which produce miscellaneous steel products has a second low point in the year ending February, 1918, from which a rise occurs until the year ending January, 1919. The second peak is slightly higher than the first.

It is evident that in all essential particulars the experience of these diverse production groups is the same as that of the fundamental departments.

The rates on which the charts are founded are presented in Table 93.

TABLE 93.—FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR MILLS MAKING SPECIFIED PRODUCTS, DECEMBER, 1913, TO DECEMBER, 1919, BY YEARS ENDING WITH EACH MONTH.

Year ending with—	Fabricated products.	Sheets.	Wire products.	Tubes.	Miscellaneous steel products.		Total.
					Group A.	Group B.	
December, 1913	100.3	61.6	59.3	27.2	70.9	41.3	60.3
January, 1914	96.2	59.9	56.5	25.6	70.1	39.4	58.7
February, 1914	92.2	58.9	54.7	24.0	69.3	38.5	57.3
March, 1914	87.9	57.7	53.1	22.5	68.6	38.9	56.1
April, 1914	88.2	56.6	53.1	21.2	67.3	35.5	54.7
May, 1914	78.7	55.0	52.5	20.1	65.5	34.2	53.2
June, 1914	75.5	53.7	51.0	19.1	62.8	33.3	51.6
July, 1914	71.9	52.4	49.6	17.3	60.6	30.4	49.9
August, 1914	66.7	49.4	48.9	16.0	57.8	31.0	47.9
September, 1914	63.2	47.4	48.0	15.0	55.7	29.4	46.3
October, 1914	61.6	47.2	46.8	13.9	53.5	28.4	45.0
November, 1914	59.5	47.3	46.7	13.2	51.8	27.4	44.0
December, 1914	59.0	47.2	46.2	12.5	50.7	27.6	43.5
January, 1915	57.0	46.9	45.4	11.8	48.4	26.9	42.4
February, 1915	55.1	46.6	45.4	11.1	45.4	27.7	41.0
March, 1915	55.0	45.1	43.7	10.2	43.5	27.1	39.3
April, 1915	53.3	44.7	43.2	9.3	42.3	26.4	39.1
May, 1915	53.3	43.0	43.3	9.0	42.1	25.1	38.3
June, 1915	51.2	41.8	44.3	8.7	42.7	23.3	38.0
July, 1915	49.3	40.0	45.1	8.8	43.5	21.8	37.6
August, 1915	50.9	39.0	46.2	9.6	45.0	20.1	38.1
September, 1915	52.2	38.5	49.9	10.0	46.8	20.4	39.5
October, 1915	51.8	38.0	51.4	10.5	48.5	21.0	40.3
November, 1915	53.0	38.1	51.5	10.7	50.4	22.1	40.9
December, 1915	53.5	37.3	52.4	10.8	51.9	23.0	41.5
January, 1916	53.4	37.0	52.6	11.1	54.7	24.5	42.4
February, 1916	53.3	37.0	52.8	11.3	57.5	25.4	43.3
March, 1916	52.8	37.3	53.3	11.6	59.8	25.3	43.9
April, 1916	52.7	37.1	52.9	12.1	61.2	25.4	44.2
May, 1916	53.9	36.8	52.9	12.2	62.0	26.1	44.6
June, 1916	54.5	36.5	52.2	12.2	62.7	27.0	44.7
July, 1916	54.1	36.6	51.5	12.4	64.3	27.5	45.1
August, 1916	54.7	36.1	51.1	12.3	66.0	28.5	45.4
September, 1916	53.5	35.7	49.7	12.2	66.7	28.7	45.2
October, 1916	53.4	35.2	48.9	12.2	67.6	29.0	45.0
November, 1916	52.4	34.9	49.3	12.1	67.9	28.7	44.9
December, 1916	52.1	34.0	48.2	12.4	67.6	28.2	44.4
January, 1917	52.9	34.1	47.1	12.0	67.2	27.4	43.9
February, 1917	53.1	33.6	46.4	12.1	66.5	26.6	43.4
March, 1917	54.0	33.1	45.5	11.9	65.5	26.2	42.8
April, 1917	54.3	32.3	45.0	11.6	64.6	25.8	42.2
May, 1917	54.0	32.2	44.2	11.5	63.6	25.3	41.6
June, 1917	53.3	32.3	42.6	11.5	62.2	24.5	40.5
July, 1917	53.1	33.6	41.0	11.1	60.2	23.5	39.4
August, 1917	52.7	34.9	39.5	10.7	57.9	22.5	38.3
September, 1917	52.7	34.2	37.2	10.6	55.8	21.5	37.0
October, 1917	52.5	34.2	36.0	10.4	54.2	21.0	36.2
November, 1917	53.2	33.8	33.9	10.3	52.9	20.6	35.3
December, 1917	51.3	33.9	32.5	10.2	51.3	20.5	34.5
January, 1918	49.1	32.0	31.6	10.3	49.9	20.1	33.6
February, 1918	48.7	33.1	30.7	10.0	48.6	20.0	32.9
March, 1918	47.4	32.7	29.1	10.0	47.6	20.8	32.3
April, 1918	46.9	32.7	27.6	10.0	46.7	21.6	31.9
May, 1918	46.3	32.3	25.8	10.0	46.0	22.7	31.8
June, 1918	45.7	31.3	24.6	9.9	45.2	24.3	31.1
July, 1918	45.1	29.4	23.4	10.0	44.5	25.9	30.7
August, 1918	42.6	27.5	22.1	9.9	44.0	28.3	30.2
September, 1918	40.8	27.4	21.2	9.8	43.5	29.2	29.9
October, 1918	40.0	26.5	19.9	9.6	42.6	29.9	29.2
November, 1918	37.8	24.9	19.0	9.5	41.7	30.7	28.9
December, 1918	38.2	25.9	18.8	9.1	42.0	31.4	28.8
January, 1919	38.5	26.1	18.2	9.1	41.9	32.1	28.9
February, 1919	37.3	26.1	17.4	9.2	41.8	31.5	28.6
March, 1919	36.8	25.7	17.0	9.2	41.5	31.2	28.3
April, 1919	35.8	25.6	16.2	9.1	41.5	30.7	28.1
May, 1919	34.4	24.9	15.7	9.0	41.1	29.9	27.6
June, 1919	33.6	24.4	15.4	8.7	40.7	28.4	27.1
July, 1919	32.7	24.2	14.7	8.8	40.0	27.6	26.7
August, 1919	32.3	24.7	14.2	8.5	39.2	25.5	26.2
September, 1919	33.3	24.8	13.5	8.6	38.8	24.7	25.9
October, 1919	33.3	25.1	13.1	8.7	38.7	24.5	25.9
November, 1919	32.6	25.5	12.9	8.8	39.2	23.7	26.0
December, 1919	32.8	23.8	12.5	9.1	39.7	23.0	26.1

TABLE 93.—FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) FOR MILLS MAKING SPECIFIED PRODUCTS, DECEMBER, 1913, TO DECEMBER, 1919, BY YEARS ENDING WITH EACH MONTH—Concluded.

NUMBER OF WORKERS.

Year ending with—	Fabricated products.	Sheets.	Wire products.	Tubes.	Miscellaneous steel products.		Total.
					Group A.	Group B.	
June, 1914	8,817	16,841	25,575	19,944	41,744	18,922	137,816
June, 1915	6,706	15,759	22,434	13,329	35,670	13,477	111,794
June, 1916	8,276	21,906	31,377	21,031	45,673	23,000	160,819
June, 1917	10,110	25,504	32,928	24,880	49,893	27,046	182,587
June, 1918	10,349	25,939	30,393	23,787	50,803	28,289	180,204
June, 1919	9,904	22,685	29,324	23,871	50,652	26,906	176,867

FLUCTUATION IN RATES FOR CAUSES.

It has been shown that certain very definite characteristics can be traced in the curves which represent the trend of accident rates over the war period. It is possible to examine the situation from another point of view. If the rates for the various causes be determined it will be possible to observe whether the indications from the groupings already presented are repeated in the various cause groups.

Table 94 shows the main cause groups.

TABLE 94.—ACCIDENT FREQUENCY RATES (PER 1,000,000 HOURS' EXPOSURE) IN THE IRON AND STEEL INDUSTRY, BY ACCIDENT CAUSES.

Accident cause.	1913	1914	1915	1916	1917	1918	1919
Machinery	7.3	5.0	4.9	5.4	4.5	4.0	3.3
Working machines	3.8	2.7	2.6	2.6	2.0	1.8	1.4
Caught in	2.5	1.8	1.7	1.7	1.2	1.1	.9
Breakage	.1	.1	.1	.1	.1	.1	.1
Moving material in	1.2	.8	.8	.8	.7	.6	.4
Cranes	3.5	2.3	2.3	2.8	2.5	2.2	1.9
Overhead	2.8	1.9	2.0	2.5	2.2	1.9	1.6
Locomotive	.3	.2	.2	.2	.2	.2	.2
Other hoisting	.4	.2	.1	.1	.1	.1	.1
Vehicles	2.3	1.9	1.6	1.7	1.7	1.3	1.2
Hot substances	5.4	3.6	3.7	4.5	3.6	3.0	2.8
Electricity	.5	.4	.2	.4	.3	.3	.2
Hot metal	3.6	2.1	2.3	3.0	2.5	2.1	2.0
Hot water, steam, etc	1.3	1.1	1.2	1.1	.8	.6	.6
Falls of persons	4.5	4.1	3.5	3.7	3.2	2.8	2.8
From ladders	.3	.1	.1	.1	.1	.2	.1
From scaffolds	.2	.2	.2	.2	.3	.2	.2
Into openings	.2	.1	.1	.3	.2	.1	.1
Due to insecure footing	3.8	3.7	3.1	3.1	2.6	2.3	2.3
Falling material, not otherwise specified	1.2	.7	.7	.6	.4	.3	.4
Handling objects and tools	26.7	19.4	20.6	21.5	15.7	12.8	11.7
Objects dropped in handling	11.2	7.3	7.6	8.4	6.1	5.5	5.0
Caught between object handled and other object	3.4	2.6	2.6	3.1	2.1	1.7	1.7
Trucks and barrows	1.9	1.0	1.4	1.4	1.2	.9	.7
Lifting or pulling	2.5	2.3	2.5	2.5	2.0	1.4	1.4
Objects flying from tools	.2	.2	.1	.1	.1	.1	.1
Slivers and edges	3.8	3.4	3.8	3.1	2.2	1.5	1.3
Using tools	3.7	2.6	2.6	2.9	2.0	1.7	1.4
Miscellaneous	12.9	8.8	6.5	7.0	5.4	4.6	4.1
Asphyxiating gas	.3	.2	.1	.1	.1	.1	.2
Flying objects not striking eye	.8	.6	.6	.5	.4	.5	.3
Flying objects striking eye	2.9	2.1	1.7	1.9	1.6	1.6	1.3
Heat cramps, etc	.9	.8	.4	.4	.1	.2	.1
Other causes	8.0	5.1	3.7	4.1	3.2	2.2	2.2
Total	60.3	43.5	41.5	44.4	34.5	28.8	26.3

It will be found that in practically all the cause groups there is a decrease after 1913 through the years 1914 and 1915, followed by increase to a peak in 1916, followed by another decrease. The handling of objects and tools produces more accidents than any other single group of causes. The rates per 1,000,000 hours' exposure for each year, beginning with 1913, are 26.7, 19.4, 20.6, 21.5, 15.7, 12.8, and 11.7. Inspection of this series discloses the characteristic high point in 1916.

It is possible to recapitulate and summarize the facts of the war period and the explanations which may be offered of the course of events. It may be noted that—

1. Whatever form of classification is used (the fundamental departments, production groups, or cause groups) the same trend is shown.

2. The period just prior to the war was a period of industrial decline. Employment went down. "Labor mobility" almost ceased. Accident rates dropped more rapidly than employment.

3. As soon as the effect of European war orders began to be felt in this country, employment began to increase. The accession of inexperienced men increased even more rapidly. Accident rates went up.

4. The iron and steel industry was alarmed by the increasing accident occurrence and undertook a strenuous counter campaign.

5. This was very successful in controlling, and in finally causing a decline in, minor injury.

6. Major injury was not controlled as perfectly but was prevented from rising above the level of 1913 and was finally considerably reduced.

This review of the war period strongly supports the contention that even in the most strenuous times it is possible to hold in check the tendency to rising accident rates by the application of the three cardinal methods of the safety movement: (1) Adequate instruction of the men in skillful methods of work; (2) Careful supervision of the well instructed man; (3) "Engineering revision," by which the safety of work places is increased.

CHAPTER XI.—STATISTICAL METHODS FOR THE SAFETY MAN.

It has been urged that the chapter in Bulletin No. 234 entitled "Methods for the Safety Man" should be expanded into a general exposition of safety methods. The literature on safety has now become so extensive that volumes would be required to contain all that can properly be said on the subject. This literature is so easily available to the safety man that it does not seem desirable in this report to go outside of its specific field in order to present the general subject of safety methods. It has accordingly been determined that the present chapter will adhere even more closely than that in Bulletin No. 234 to a statement of those statistical methods which, having been tried in connection with the bureau's study of the accident problem, have been found to be useful.

It is believed that it will be of interest and may afford some practical suggestions to outline the procedure of the bureau in the handling of the material on which it bases its discussions.

The specially significant items of the reports of the bureau are the rates of various sorts. These are essentially ratios between the number of hours of exposure to hazard, used as a base, and the number of occurrences, such as accidents, accessions to or dismissals from service etc., which happened in the conduct of the concerns under consideration.

As a basis for the calculation of such rates, two items of information are necessary: 1. A record of "man hours," classified in accordance with the departments of the plant and where possible by occupations, age groups, and other subdivisions of the working force which it may be desired to study; 2. Accurate statements, for specified periods, of the occurrences whose relation to the working force it is desired to determine.[1] The reports from the plants which are included in the bureau's studies, giving "man hours" or other information from which "man hours" may be determined, are received annually upon the form shown.

REPORT OF EMPLOYMENT.

Company.................................. Plant.................................. Year............

Department.	Total hours worked by all men as shown by time books.	If total hours are not available report as below.		
		Average number employed.	Days department was in operation.	Usual length of day or turn.

[1] A full exposition of the method of preparing such rates is to be found in Chapter II.

The accident records are received either in classified and tabulated form as shown in the following form, or the records of the individual cases of personal injury are transmitted.

SCHEDULE OF DISABLING ACCIDENTS (RESULTING IN DEATH, PERMANENT DISABILITY, OR TEMPORARY DISABILITY BEYOND DAY OF INJURY) OCCURRING DURING THE YEAR ENDING DECEMBER 31, 192

Name of company ....; Name of plant ....

Department of plant.		Accidents resulting in permanent disability.[a]																										Accidents resulting in temporary disability terminating in—									
		Total.							Partial.[b]																												
	Death.	Loss of both arms.	Loss of both legs.	Loss of both hands.	Loss of both feet.	Loss of both eyes.	Other.	Total.	Loss of 1 arm.	Loss of 1 hand.	Loss of 1 leg.	Loss of 1 foot.	Loss of 1 eye.	Loss of 1 thumb.	Loss of 1 finger.	Loss of 2 fingers.	Loss of 3 fingers.	Loss of 4 fingers.	Loss of thumb and 1 finger.	Loss of thumb and 2 fingers.	Loss of thumb and 3 fingers.	Loss of thumb and 4 fingers.	Loss of great toe.	Loss of any 2 toes.	Other.	Total.	Grand total.	First week.	Second week.	Third week.	Fourth week.	Fifth week.	Sixth to thirteenth week.	Fourteenth week or later.	Duration of disability not known.	Total.	Grand total.

[a] Cases of plural injuries which might be entered in more than one of these classes should be entered but once under what is regarded as the more severe injury. An injury included among permanent injuries should not be placed also among temporary disabilities. Amputation between the knee and the ankle or between the elbow and wrist is considered as the loss of a foot or a hand, at or above the knee or elbow as the loss of a leg or an arm.

[b] Loss of a phalanx, permanent malformation, or permanent stiffness of a joint is regarded as equivalent to the loss of the member.

If the individual cases are reported, it is done either in the form of a duplicate of some record prepared by the plant for its own use or the items are transcribed upon a special card furnished by the bureau. In order to indicate the method of using this card, it is here presented completely filled out.

RECORD OF ACCIDENT.

Establishment No. *69.* Date, *5/4/15.* Hour, *5 p.* Age, *38.* Sex, *M.* Married, *Yes.*
Dependents, how many? *3.* Speak English? *Yes.* Race, *Slav.* Dept. *Axle works.*
Occupation, *Laborer.* Worked for company how long? *6 years.*
Had the injured worked in the industry elsewhere? ——. If so, how long? ——.
Machine, tool, appliance, object, or condition in connection with which accident occurred? *Crane.*
Describe in full how the accident happened: *Hooking lift of plate. It lowered on his foot.*
What part of the body was injured? *Foot.* Was the injury an abrasion, bruise, cut, laceration, puncture, burn, scald, concussion, dislocation, fracture, sprain, strain, dismemberment by the accident, nervous shock, or other? *Contusion.* Did the injury become infected? *No.*
Results of injury: DEATH? *No.* PERMANENT DISABILITY? *No.* If so, state nature. ——.
TEMPORARY DISABILITY? *Yes.* Days lost, 70.

SPACES RESERVED FOR CODES.

Serial No. *16019.*	Dept., *25.*	Year, *15.*	Month, *5.*	Day of week, 3.	Hour, *12.*
Age, *38.*	Sex, *1.*	Conj. cond., *1.*	Depend., *03.*	English, *1.*	Race, *25.*
Experience, **10.*	Occ., *098.*	Cause, *1.*	Cause anal., *082.*	Part, *0.*	Mode, *0.*
Location, *61.*	Nature, *02.*	Result, *3.*	Per. dis., *00.*	Temp. dis., *12.*	Time, *0070.*

It will be noticed that the upper part of this card record contains spaces in which such items as the date, the hour, the age, sex, cause of injury etc., may be entered. On the lower part of the form are spaces in which code numbers are to be entered. The codes which have been used recently by the bureau are as follows:

CODES FOR TABULATION OF ACCIDENT DATA.

SERIAL NUMBER.

B. L. S. filing number.

MONTH.

Recorded number.

YEAR.

Terminal digits.

DAY OF WEEK.

	Code No.
1 to 7.	
Unknown	9

HOUR.

Beginning—	Day.	Night.
6	01	13
7	02	14
8	03	15
9	04	16
10	05	17
11	06	18
12	07	19
1	08	20
2	09	21
3	10	22
4	11	23
5	12	24
Unknown	00	00

AGE.

Recorded age.	
Unknown	00

SEX.

Male	1
Female	2
Unknown	9

CONJUGAL CONDITION.

Married	1
Single	2
Widowed	3
Divorced	4
Unknown	9

DEPENDENTS.

Recorded number.	
None	00
Unknown	99

RESULTS.

	Code No.
Death	1
Permanent disability	2
Temporary disability	3

ENGLISH SPEAKING.

Yes	1
No	2
Unknown	9

DEPARTMENTS.

Blast furnaces	01
Bessemer	02
Open hearths	03
Duplex	04
Crucible	05
Electric	06
Foundries	07
Bar mills	09
Heavy rolling mills	10
Plate mills	11
Puddling mills	12
Rod mills	13
Sheet mills	14
Tube mills	15
Miscellaneous	16
Fabrication	17
Forges	18
Wire drawing	19
Electrical	20
Mechanical	21
Power houses	22
Yards	23
Coke	24
Armor	25
Axles	26
Car wheels	27
Docks	28
Erecting	29
Fence	30
Nails	31
Hot mills	32
Cold rolling mills	33
Unclassified	98
Unknown	99

RACE.

	Code No.
American (white)	01
Austrian	02
Belgian	03
Bulgar	04
Dane	05
English	06
Finn	07
French	08
German	09
Greek	10
Hebrew	11
Hollander	12
Hungarian	13
Italian	14
Irish	15
Lithuanian	16
Montenegrin	17
Norwegian	18
Pole	19
Portuguese	20
Rumanian	21
Russian	22
Scotch	23
Serb	24
Slav	25
Spaniard	26
Swede	27
Swiss	28
Turk	29
Welsh	30
American (Negro)	31
Unclassified	98
Unknown	99

EXPERIENCE.

1 week and under	1
Over 1 and not over 2 weeks.	2
Over 2 and not over 3 weeks.	3
Over 3 weeks and not over 1 month	4
Over 1 and not over 3 months.	5
Over 3 and not over 6 months.	6
Over 6 months and not over 1 year	7
Over 1 and not over 2 years	8
Over 2 and not over 5 years	9
Over 5 and not over 10 years.	*10
Over 10 years	*11
Unknown	*12

PERMANENT DISABILITY—TIME EQUIVALENTS.

Part of body.	For loss.	For disability.	Equivalent.	Part of body.	For loss.	For disability.	Equivalent.
	Code No.	*Code No.*			*Code No.*	*Code No.*	
Eyes	01	......	6000	Thumb and 4 fingers	18	42	2400
Arms	02	......	6000	1st finger	19	43	0300
Hands	03	......	6000	2d finger	20	44	0300
Legs	04	......	6000	3d finger	21	45	0300
Feet	05	......	6000	4th finger	22	46	0300
Hand and foot	06	......	6000	Any 2 fingers	23	47	0750
Mind	09	......	6000	Any 3 fingers	24	48	1200
Other	10	......	6000	Any 4 fingers	25	49	1800
Arm	11	35	4000	Leg	26	50	4000
Eye	12	36	1800	Foot	27	51	2400
Hand	13	37	3000	Great toe	28	52	0300
Thumb	14	38	0600	Any 2 toes	29	53	0300
Thumb and 1 finger	15	39	1200	Nonpermanent	00	......	....
Thumb and 2 fingers	16	40	1500	Unknown	99	......	....
Thumb and 3 fingers	17	41	2000				

TEMPORARY DISABILITY.

	Code No.		Code No.
1 day	01	57 to 63 days	11
2 days	02	64 to 70 days	12
3 to 7 days	03	71 to 77 days	13
8 to 14 days	04	78 to 84 days	14
15 to 21 days	05	85 to 91 days	15
22 to 28 days	06	92 to 365 days	16
29 to 35 days	07	Over 365 days	17
36 to 42 days	08	Nontemporary	00
43 to 49 days	09	Unknown	99
50 to 56 days	10		

OCCUPATIONS IN THE IRON AND STEEL INDUSTRY.

	Code No.		Code No.		Code No.
Assemblers	001	Finishers	072	Press hands	142
Axle cutters	002	Firemen	073	Puddlers	143
Axle finishers	003	Fitters	074	Pullers out	144
Axle makers	004	Foremen	075	Pump men	145
Axle turners	005	Furnace men	076	Punchers	146
Ball cleaners	006	Gaggers	077	Pushers	147
Ballers	007	Gas makers	078	Rammers	148
Barbed-wire operators	008	Gas washers	079	Reamers	149
Bar and clay men	009	Gaugers	080	Regulators	150
Bar pullers	010	Grinders	081	Reelers	151
Bellers	011	Guide setters	082	Repair men	152
Bench and vise hands	012	Hammermen	083	Riggers	153
Benders	013	Handy men	084	Riveters	154
Bending machine operators	014	Heaters	085	Roll engineers	155
Blacksmiths	015	Hookers	086	Rollers	156
Bloom runners	016	Hook runners	087	Rollers off	157
Blowers	017	Hook ups	088	Roll hands	158
Boiler cleaners	018	Horseshoe operators	089	Roughers	159
Boiler makers	019	Hot bed men	090	Rumblers	160
Bolters	020	Ingot car operators	091	Runner men	161
Bottom fillers	021	Ingot stripper	092	Samplers	162
Bottom house men	022	Inspectors	093	Sand blasters	163
Bottom makers	023	Iron breakers	094	Saw men	164
Brakemen	024	Iron handlers	095	Scale car operators	165
Bricklayers	025	Keepers	096	Scale men	166
Bucklers	026	Knobblers	097	Scrap men	167
Buck ups	027	Laborers	098	Screw downs	168
Bundlers	028	Ladle liners	099	Shaker men	169
Bushelers	029	Ladle men	100	Shear men	170
Cabinet makers	030	Lamp trimmers	101	Sheet-iron workers	171
Cable makers	031	Lathe hands	102	Shippers	172
Cagers	032	Larry men	103	Shovelers	173
Car dump operators	033	Layers out	104	Skip hoist operators	174
Carpenters	034	Lever men	105	Socket bellers	175
Casting cleaners	035	Line drawers	106	Socket benders	176
Catchers	036	Linemen	107	Socket heaters	177
Calkers	037	Loaders	108	Socket reamers	178
Chargers	038	Loom operators	109	Socket tappers	179
Charging car operators	039	Machinists	110	Squeezer men	180
Charging crane operators	040	Machine hands	111	Stampers	181
Chippers	041	Manipulators	112	Steel pourers	182
Cinder men	042	Markers	113	Stick ins	183
Cinder snappers	043	Matchers	114	Stockers	184
Clampers	044	Melters	115	Stopper setters	185
Clippers	045	Manganese heaters	116	Stove cleaners	186
Conveyor men	046	Millwrights	117	Stove tenders	187
Core makers	047	Mixer men	118	Straighteners	188
Counters	048	Motormen	119	Stranders	189
Cover operators	050	Mold cappers	120	Switchmen	190
Crane hookers	051	Mold car cleaners	121	Tablemen	191
Cranemen	052	Molders	122	Take offs	192
Cross rollers	053	Nail machine operators	123	Tappers	193
Cupola chargers	054	Oilers	124	Teamsters	194
Cupola liners	055	Openers	125	Teemers	195
Cut-off men	056	Ore bridge operators	126	Tinsmiths	196
Die reamers	057	Painters	127	Tong carriers	197
Die setters	058	Pattern filers	128	Tong cleaners	198
Door operators	059	Pattern makers	129	Tong men	199
Doublers	060	Piercers	130	Tong runners	200
Drag downs	061	Pig-machine men	131	Tong take offs	201
Drag outs	062	Pilers	132	Top fillers	202
Draw bench men	063	Pipe carriers	133	Toppers	203
Drillers	064	Pipe cutters	134	Transfer car men	204
Drop men	065	Pipe fitters	135	Truckers	205
Dustmen	066	Pipe patchers	136	Turndowns	206
Electricians	067	Pipe testers	137	Tuyere men	207
Erectors	068	Pit men	138	Unloader operators	208
Engineers	069	Plumbers	139	Vessel men	209
Feeders	070	Pointers	140	Water tenders	210
Fence makers	071	Pot fillers	141	Weighers	211

OCCUPATIONS IN THE IRON AND STEEL INDUSTRY—Concluded.

	Code No.		Code No.		Code No.
Welders	212	Burners	221	Standpipe men	230
Winders	213	Rivet heaters	222	Breeze men	231
Wire cleaners	214	Wheel rollers	223	Luters	232
Wire drawers	215	Wheel turners	224	Door cleaners	233
Wiremen	216	Structural-iron workers	225	Tarmen	234
Wire spoolers	217	Forging-press operators	226	Damper men	235
Watchmen	218	Lid men	227	Still operators	236
Yard masters	219	Vat men	228	Motor-truck drivers	237
Bolt threaders	220	Salt men	229		

GENERAL CAUSE GROUPS.

	Group.
Machinery	1
Boilers and steam-pressure apparatus	2
Vehicles	3
Hot substances, explosives, etc	4
Poisons	5
Falls of persons	6
Falling objects	7
Objects and tools being handled	8
Unclassified	9
Unknown	0

CAUSE GROUP NO. 1—MACHINERY.

	Code No.
Prime movers and power transmission:	
Steam engines	001
Internal-combustion engines	002
Dynamos and motors	003
Compressed-air motors	004
Water motors	005
Other prime movers	006
Shafts	007
Shaft collars and couplings	008
Set screws, keys, and bolts	009
Belts and pulleys	010
Chains and sprockets	011
Ropes, cables, etc	012
Cogs, cams, gears, etc	013
Working machines:	
Bending rolls	014
Bolt and nut machines	015
Boring mills	016
Bulldozers	017
Bundlers	018
Charging cars	019
Charging cranes	020
Chipping hammers	021
Doublers	022
Drill presses	023
Drills, portable electric	024
Drills, portable pneumatic	025
Forging hammers	026
Gear cutters	027
Grinding wheels	028
Hot and cooling beds	029
Ingot cars	030
Lathes, general	031
Lathes, turret	032
Lathes, wood	033
Millers	034
Molding machines	035
Mud gun	036
Pig breaker	037
Pig machine	038
Planers, metal	040
Planers, wood	041
Presses, punch	042
Presses, stamping	043
Pushers	044
Reamers	045
Riveters	046
Rolls	047
Roll tables	048
Rotary shears	049
Sand rammers	050
Saws, band	051
Saws, crosscut	052
Saws, metal	053
Saws, rip	054

CAUSE GROUP NO. 1—MACHINERY—Concluded.

Working machines—Concluded.	Code No.
Shapers	055
Shears	056
Skull crackers	057
Slitters	058
Slotters	059
Stone crushers	060
Straighteners	061
Tappers	062
Threaders	063
Transfer tables	064
Tube drawing benches	065
Wire-drawing benches	066
Welders, etc	067
Welders, oxyacetylene	068
Power hammers	069
Butt welders	070
Lap welders	071
Forging press	072
Elevator accidents	075
Crane, caught by chain or hook	078
Crane, car striking person	079
Crane, cable catching person	080
Crane, load swinging	081
Crane, load lowering	082
Crane, load falling	083
Crane, load falling, broken machinery	084
Crane, load falling, hitch slipped	085
Crane, objects falling from crane	086
Crane, falls from crane or truck	087
Crane, other accidents	088
Derricks	089
Construction hoists and elevators	090
Blocks and tackles, windlasses, etc	091
Conveyors	092
Gantry cranes	093
Locomotive cranes	094
Pumps	095
Fans and blowers	096
Unclassified	198
Not reported	199

MACHINES—PART OF MACHINE.

	Code No.
Point of operation	1
Belts	2
Cranks and eccentrics	3
Fly wheels	4
Gears	5
Set screws, keys and bolts	6
Counterweights	7
Other parts	8
Unknown	9
Nonmachine	0

MACHINES—MODE OF OCCURRENCE.

	Code No.
Adjusting, machine, tool, or work	1
Starting, stopping, or operating	2
Cleaning and oiling	3
Repairing	4
Breaking of machine or tool	5
Objects flying from machine	6
Other conditions	7
Unknown	9
Nonmachine	0

GENERAL CAUSE GROUPS—Continued.

Cause Group No. 2—Boilers and Steam Pressure Apparatus.

	Code No.
Boilers, explosions	200
Boilers, all other	201
Steam pipes, explosions	202
Steam pipes, all other	203
Gauges, explosions	204
Gauges, all other	205
Other apparatus, explosions	206
Other apparatus, all other	207
Unknown	299

Cause Group No. 3—Vehicles.

	Code No.
Steam and electric railways:	
Train wrecks, collision	301
Train wrecks, derailment	302
Falls, getting on or off, in motion	303
Falls, getting on or off, at rest	304
Falls, riding on, sudden start or stop	305
Falls, riding on, slipping or lost balance	306
Falls, riding on overhead structure	307
Falls, riding on side structure	308
Falls, not otherwise classified	309
Struck by or caught between	310
Coupling or uncoupling	311
Switching	312
Repairing engines or cars	313
Repairing track	314
Crossing track	315
Standing or walking on track	316
Setting or releasing hand brakes	317
Objects falling from	318
Other accidents	319
Auto vehicles:	
Collisions with cars or engines	330
Collisions with other vehicles	331
Collisions with stationary objects	332
Overturning	333
Cranking	334
Falls from	335
Struck by	336
Objects falling from	337
Objects shifting on load	338
All other	339
Animal-drawn vehicles:	
Collisions with cars or engines	350
Collisions with other vehicles	351
Collisions with stationary objects	352
Overturning	353
Whiffletrees	354
Falls from	355
Struck by	356
Objects falling from	357
Objects shifting on load	358
All other	359
Water transportation:	
Collisions with vessels	370
Collisions with other objects	371
Capsizing	372
Hawsers and other ropes	373
All other	374
Not classified	398
Not reported	399

Cause Group No. 4—Hot and Corrosive Substances, Explosives, Electricity, and Fires.

	Code No.
Explosives, storage	401
Explosives, transportation and handling	402
Explosives, blasting	403
Explosives, dust	404
Explosives, gas	405
Explosives, gasoline	406
Explosives, other	407
Electricity, short circuits at switches	408
Electricity, contact exposed conductors	409
Electricity, other	410
Conflagrations	411
Hot substances and flames, asphalt, etc.:	
Hot substances, liquids, water	413
Hot substances, liquids, other liquids	414
Hot substances, metal, falls on sheets	415
Hot substances, metal, handling sheets	416
Hot substances, hot bars in rolls	417
Hot substances, hot scale	418

Cause Group No. 4—Hot and Corrosive Substances, Explosives, Electricity, and Fires—Concluded.

	Code No.
Hot substances and flames, asphalt, etc.—Concluded.	
Hot substances, hot stock ejected	419
Hot substances, rod loops	420
Hot substances, molten metal, breakouts	421
Hot substances, molten metal, explosions	422
Hot substances, molten metal, ingot explosions	423
Hot substances, molten metal, sparks and splashes	424
Hot substances, molten metal, spills	425
Hot substances, molten metal and slag, other	426
Hot substances, steam	427
Hot substances, flames	428
Hot substances, all other	429
Corrosive substances	430
Unclassified	498

Cause Group No. 6—Falls of Persons.

	Code No.
From benches, boxes, chairs, and tables	601
From boats, bridges, dams, and docks	602
From buildings, in construction or demolition	603
From cranes, derricks, or hoists, in erecting or rigging	604
From floors, temporary	605
From ladders	606
From engines, boilers, and machines	607
From piles	608
From poles and trees	609
From roofs	610
From runways, balconies, and platforms	611
From scaffolds or staging	612
From stairs	613
From tramways and trestles	614
From windows or wall openings	615
From other elevations	616
Into bins and vats	617
Into floor openings	618
Into manholes	619
Into excavations	620
Due to slipping on level	621
Due to stumbling on level	622
Other falls	698

Cause Group No. 7—Falling Objects.

	Code No.
Collapse of building or walls	701
Collapse of piled material	702
Collapse of scaffolds or staging	703
From buildings	704
From chutes, conveyors, or slides	705
From machines or work benches	706
From piles	707
From racks and shelves	708
From runways, balconies, etc	709
From scaffolds and staging	710
From temporary floors	711
From tramways and trestles	712
From other elevations	713
Into ditches or trenches	714
Into other excavations	715
Cave in of ditches	716
Cave in of tunnels	717
Cave in of other excavations	718
Falling poles	719
Falling trees and limbs	720
Objects tipping over (not vehicles)	721
Other falling objects	798

Cause Group No. 8—Objects and Tools Being Handled.

	Code No.
Objects dropped in handling	801
Caught between object handled and other object	802
Lifting or pulling, causing strain	803
Handling glass	804
Handling sheet metal	805
Handling objects with protruding nails	806
Handling other sharp objects	807

GENERAL CAUSE GROUPS—Concluded.

CAUSE GROUP NO. 8—OBJECTS AND TOOLS BEING HANDLED—Continued.

	Code No.
Handling trucks or barrows, collide with person	808
Handling trucks or barrow, collide with objects	809
Handling trucks or barrows, overturn	810
Handling trucks or barrows, objects fall from	811
Handling trucks or barrows, other accidents	812
Tools in hands of worker:	
Tools, glance or slip	813
Tools, break or come apart	814
Tools, objects fly from, not otherwise specified	815
Tools, objects fly from nails and spikes	816
Tools, objects fly from metal chips	817
Tools, objects fly from stone or cement	818
Tools in hands of fellow worker:	
Tools, glance or slip	819
Tools, break or come apart	820
Tools, objects fly from, not otherwise specified	821
Tools, objects fly from nails and spikes	822

CAUSE GROUP NO. 8—OBJECTS AND TOOLS BEING HANDLED—Concluded.

Tools in hands of fellow worker—Concluded.

	Code No.
Tools, objects fly from metal chips	823
Tools, objects fly from stone or cement	824
Unclassified	898

CAUSE GROUP NO. 9—MISCELLANEOUS CAUSES.

	Code No.
Animals	901
Asphyxiating gas	902
Cold	903
Doors, windows, etc	904
Drowning	905
Flying objects (not otherwise classified)	906
Heat	907
Lightning	908
Nails and sharp objects stepped on	909
Violence	910
Striking against objects	911
Uneven footing	912
Moving objects not otherwise classified	913
All other	998

LOCATION OF INJURY.

	Code No.
Head:	
Brain	01
Eye	02
Both eyes	03
Internal ear	04
Both internal ears	05
External ear	06
Skull	07
Scalp	08
Head, not otherwise classified	09
Face and neck:	
Forehead	10
Eyelids	11
Nose	12
Cheek	13
Upper jaw	14
Lower jaw	15
Teeth	16
Tongue	17
Lips and chin	18
Face, not otherwise classified	19
Neck	20
Trunk:	
Back	21
Vertebrae	22
Thorax, external	23
Thorax, internal	24
Abdomen, external	25
Abdomen, internal	26
Groin	27
Pelvis	28
Generative organs	29
Upper extremities:	
Scapula	30
Clavicle	31
Shoulder	32
Upper extremities—Concluded.	
Humerus	33
Upper arm	34
Elbow	35
Ulna	36
Radius	37
Both ulna and radius	38
Forearm	39
Wrist	40
Hand	41
Both hands	42
One finger	43
Two fingers	44
Three fingers	45
Four fingers	46
Thumb	47
Thumb and 1 finger	48
Thumb and 2 fingers	49
Thumb and 3 fingers	50
Thumb and 4 fingers	51
Lower extremities:	
Hip	52
Femur	53
Upper leg	54
Knee	55
Tibia	56
Fibula	57
Both tibia and fibula	58
Lower leg	59
Ankle	60
Foot	61
Both feet	62
Great toe	63
Any two toes	64
Unclassified	98
Unknown	99

NATURE OF INJURY.

	Code No.
Abrasion	01
Bruise	02
Cut	03
Laceration	04
Puncture	05
Burn or scald	06
Concussion	07
Dislocation	08
Fracture	09
Sprain or strain (not hernia)	10
Accidental dismemberment	11
Nervous shock	12
Abrasion with infection	
Cut with infection	14
Laceration with infection	15
Puncture with infection	16
Burn or scald with infection	17
Fracture with infection	18
Hernia	19
Asphyxia	20
Electric flash	21
Crushing injury	22
Heat exhaustion	23
Other	98
Unknown	99

The card is so arranged that it can be placed upon the typewriter and the various items entered in sequence. The entry of the code numbers is, of course, greatly facilitated if the record has been copied upon the upper half of the card by the plant, since, in that case, when placed upon the typewriter the record to be translated into terms of the code is in a convenient position to be inspected and the proper code numbers determined.

In those cases where a duplicate report of one prepared by the plant for its own use is sent in, the items on it are not copied but the translation into code numbers is made directly from the original and entered upon the bureau card. In that case the upper portion of the card is left blank and the card contains only the series of code numbers.

This process brings all of the individual records into a form convenient for filing and reference, and facilitates the next step of the process, which consists in transferring the code numbers to punched cards. A form of this card is shown on page 296.

The process of sorting and tabulating these punched cards is familiar to those who have had occasion to use the system in cost accounting and other similar operations and can not be readily described in such manner as to render it intelligible to those who have not seen the apparatus. It will be sufficient to indicate the procedure in a simple case. Let it be supposed that the interest is in the causes of injury. The principal cause groups are recorded by means of the code figures from 1 to 9 in column 27 of the punched card. The machine will be set to sort the cards in accordance with the figures in that column. The result of the operation will be to place the cards numbered from 1 to 9 in their respective compartments. The cards in compartment 4, for instance, are for accidents due to explosives, electricity, and hot and corrosive substances, and those in compartment 7 pertain to cases of injury due to falling objects. If it is desired to know the number of men of the several races injured in accidents from falling objects, the cards in compartment 7 will be reassorted by setting the machine for columns 21 and 22. As a result of this reassorting all cards marked 01, which represent the American whites, will be in one group, those marked 19, representing Polish workers in another; and so on.

It is evident that by reassorting the cards into the many possible interrelated groups indicated by the printed titles it would be possible to establish a very great number of interrelations, some of them significant and others having little or no meaning.

This assortment of the cards will determine the number of cases belonging to specific classifications. It has been repeatedly emphasized that a study of the number of cases as related to the working force fails signally to bring out many important facts in the situation. There is need also for some index of the severity of the cases falling under the various classifications. Knowledge on this point is obtained by utilizing the record found in columns 42 to 45. If the card is one for a fatal case 6,000 will be punched out in these columns. If a disability of one day beyond the day of injury is represented, the figures punched will be 0001. In a given group of cards there will be material variation, depending upon the degree of severity in the individual cases. If it is desired to know what the loss equivalent to the injuries arising from falling objects is, the cards from compartment 7, as originally sorted, will be put through another machine, which adds the time losses recorded in columns 42 to 45. It is obvious that the equivalent time losses occurring in any grouping which has been determined by the previous sorting may be learned by putting the cards through this tabulator.

Serial number.					Depart-ment.		Year.		Month.	Day of week.	Hour.		Age.		Sex.	Conj. cond.	Dependents.		English.	Race.		Experience.	Occupa-tion.			Cause.	Cause analyzed.			Part.	Mode.	Location.		Nature.		Result.	Permanent disability.		Temporary disability.		Time allowance.			
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45

The information thus obtained regarding the cases of accident may now be formulated as rates by computing the ratio between the man hours and the number of cases, giving frequency rates, or between man hours and the equivalent days of loss, giving severity rates. In the standard table used in different parts of this report and shown below these frequency and severity rates are given for cases of death, permanent disability, and temporary disability.

(1)	Number of workers.	Number of cases.				Accident frequency rates (per 1,000,000 hours' exposure).				Accident severity rates (per 1,000 hours' exposure).			
		Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.	Death.	Permanent disability.	Temporary disability.	Total.

[1] This space is for entering department, occupation, etc.

The foregoing gives an idea of the treatment of the data coming into the bureau in the form of records of individual cases.

Tabulated records.—It has been noted above that besides the records of individual cases a considerable body of records comes to the bureau in the form of tabulations. From these tabulated records it has been possible directly to calculate the frequency rates. Determination of severity rates involves more extended computation. For example, all cases of death must be multiplied by 6,000; loss of thumb, by 600; disabilities terminating in 7 days or less, by 3.5. By computations such as these the time allowances pertaining to the several departments may be determined. Since the classification is never expanded beyond the departments into occupations, only departmental rates can be determined from these tabulated reports, and it is manifest that no study of causes is possible from such tabulation.

THE USE OF RECORDS AND CHARTS.

The safety man will very soon find it desirable, even necessary, to put his records into such shape that they may be readily understood by the management. He must show in what departments of the plant under his charge changes in accident occurrences are happening, either improvement or the opposite.

It may properly be emphasized again at this point that no trustworthy conclusions can be arrived at regarding these matters unless the accident occurrences are related to the amount of exposure. In other words, rates of various sorts must be prepared which will indicate the nature of the changes which are going on. It may also be said that exclusive attention to frequency rates is always liable to lead to wrong conclusions, and it is certain that at intervals such errors will intrude if the factor of severity is not properly considered.

As a direct and forcible method of presenting the facts with regard to accident occurrences and accident prevention, no method has proved equal to the graphic chart. If such charts are made with due regard to simplicity and clearness, a large amount of information can be compressed into small space and made to appeal very directly to the observer.

There are two things which may be conveyed by the graphic method: (1) A comparison of absolute amounts and (2) the direction and rate of change which is occurring. It has not always been the case that a clear distinction has been made between these two entirely different ideas which may be embodied in a chart.

Differences in absolute amounts may be shown by charts such as Chart 15, shown on page 216.

That chart shows by means of the horizontal bars of which it is composed the size of the accident severity rates in the iron and steel industry over a period of years. It also shows what contribution to this total severity was made by each of three factors; namely, death, permanent disability, and temporary disability.

Such charts are sometimes made with the bars vertical instead of horizontal. This is an undesirable arrangement since it is much less easy for the eye to make comparison of vertical distances than it is of horizontal distances.

Whenever, therefore, it is possible to use the arrangement shown of the elements making up the chart it is desirable to do so.

SMOOTHED CURVES.

It is usually desirable to consider the course of events in the matter of accident occurrences in the plant as often as once a month. One difficulty is immediately encountered, even in establishments of considerable size, when the monthly unit is adopted. The amount of exposure and the number of cases are so small that very violent and perplexing fluctuations may occur which tend to obscure the real course of events. When, on the other hand, comparisons are made only between successive annual periods, the comparison is so delayed as to lose a large part of its value.

It is desirable, therefore, to adopt, if possible, some method which permits of a monthly presentation of relations and at the same time deals with amounts of exposure and number of cases sufficiently large to get away from the influence of special local conditions.

This is accomplished by the use of overlapping 12-month periods. For example, instead of computing rates for the month of January, February, etc., the rates are computed for the entire year ending with each of those months. These rates are then arranged in a series and by their rise and fall indicate in a satisfactory manner the general trend of events.

The results of the application of this method can best be understood by the comparison of charts plotted from month to month and the same data plotted by full years ending with those months.

Chart 58 shows the frequency rates by individual months from December, 1914, to October, 1916, for five of the important departments of a large steel works. Charts of this form have been very considerably used by safety men and when the fluctuations are not great and the number of departments presented is relatively small they give a fairly satisfactory picture of conditions and permit a ready comparison between the months. It is evident, however, that where the fluctuations are such as those shown in this chart, it becomes very confusing and the tracing of the record of the individual departments is extremely difficult.

In Chart 59 the same data are presented modified so as to show the rates for the full years ending with the months instead of the monthly rates as in the preceding chart. It is possible in this chart to trace the relations between the several departments. For example, in the early part of the chart accident rates in the mechanical department

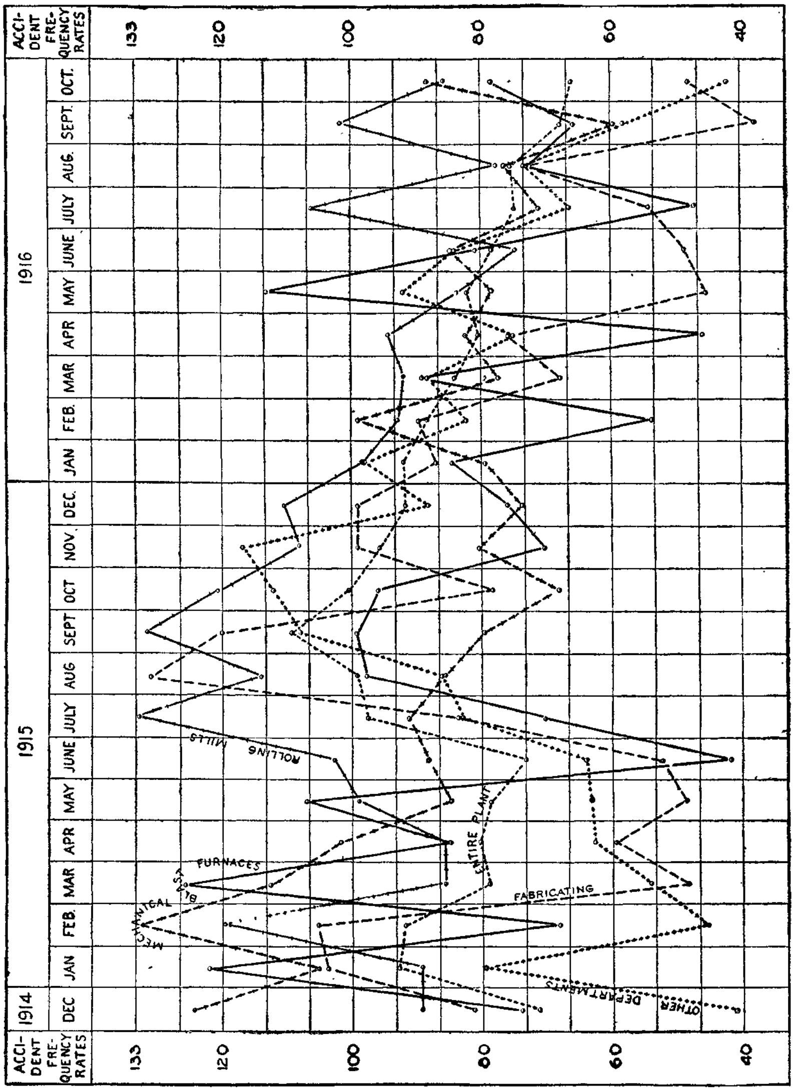


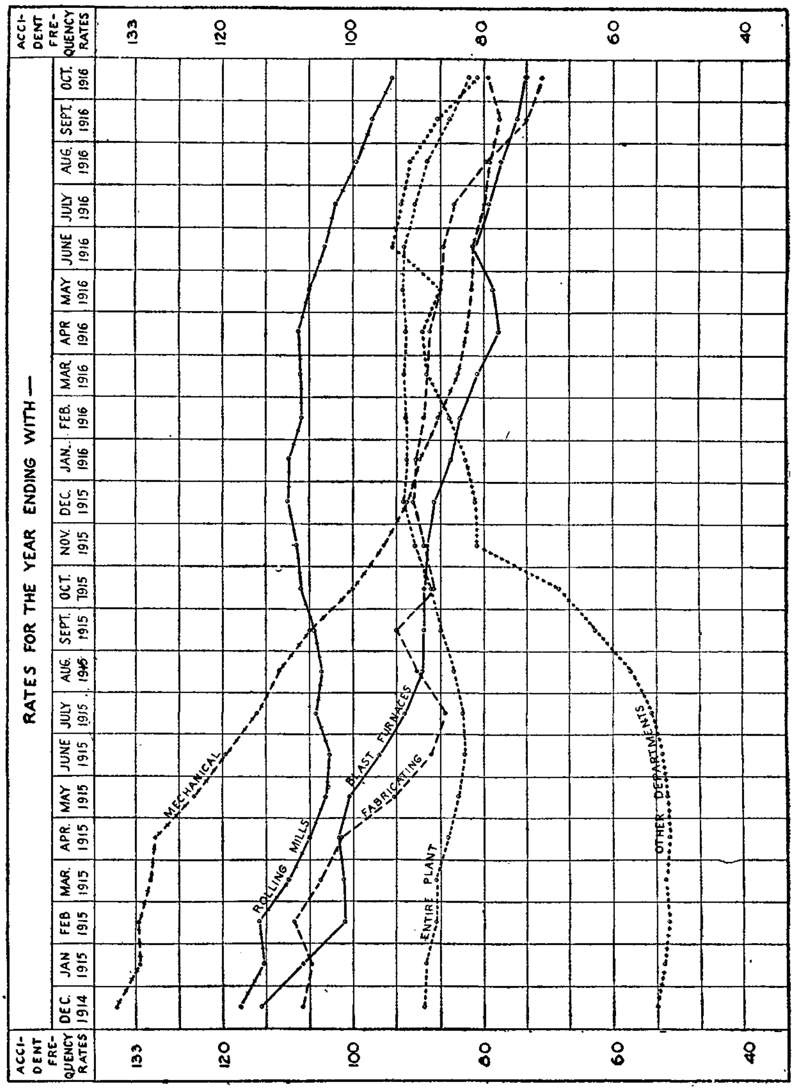
CHART 58.—ACCIDENT RATES PLOTTED BY MONTHS.

were materially higher than the rates in rolling mills. By the close of the period they were considerably less. Also a changed condition in a particular department becomes promptly evident and provides a better basis for an intelligent conclusion regarding what ought to be done in that department than the violent changes which are indicated in many cases by the monthly summary.

PREPARATION OF "SMOOTHED CURVES."

The description of the steps by which charts such as Chart 59 are prepared may seem somewhat complicated. This impression is

CHART 59.—ACCIDENT RATES PLOTTED BY OVERLAPPING 12-MONTH PERIOD.



due rather to the number of items which must be considered than to any complication in their relationships.

The form introduced below is convenient for the entering of information necessary to the preparation of charts of this character.

Months.	Man-hours.				Accidents.				Frequency rates by years ending—	
	By months.		By years ending—		By months.		By years ending—			
	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915
	1	2	3	4	5	6	7	8	9	10
January	195,000	123,000		2,154,000	37	15		232		108
February	207,000	162,000		2,109,000	30	12		214		101
March	204,000	159,000		2,064,000	24	20		210		102
April	198,000				17					
May	198,000				24					
June	198,000				19					
July	201,000				22					
August	177,000				22					
September	177,000				18					
October	177,000				17					
November	135,000				10					
December	159,000		2,226,000		14		254		114	
Total	2,226,000				254					

The above form is arranged to carry data for two years. It is, of course, possible to increase the number of years indefinitely. In the columns at the left the "man hours" of the individual months are entered. The total of the first column is the man hours for the year ending with December, 1914. In the next two columns are entered the man hours for the 12 month-period ending with each specified month. The total for 1914 is 2,226,000 hours. To obtain the figure for the year ending with January, 1915, we subtract from this total the hours of exposure for January, 1914, and add the hours of exposure for January, 1915 $(2{,}226{,}000-195{,}000+123{,}000=2{,}154{,}000)$. Proceeding in this manner, from month to month, we obtain the hours of exposure for the years ending in each month of the period covered. The next two columns contain the number of accidents which occurred in each month. The total of column 5 is the number of accidents (254) which occurred in the year ending with December, 1914. Applying a formula similar to that used for the hours of exposure $(254-37+15=232)$ gives the number of accidents for the year ending with January, 1915. Repeating the process gives $(232-30+12=214)$ the accidents for year ending February, 1915, and so on to the end of the series.

Lastly, there are two columns in which frequency rates are entered. These are obtained by dividing the number of accidents, as found in columns 7 and 8, by the number of man hours, as found in columns 3 and 4.

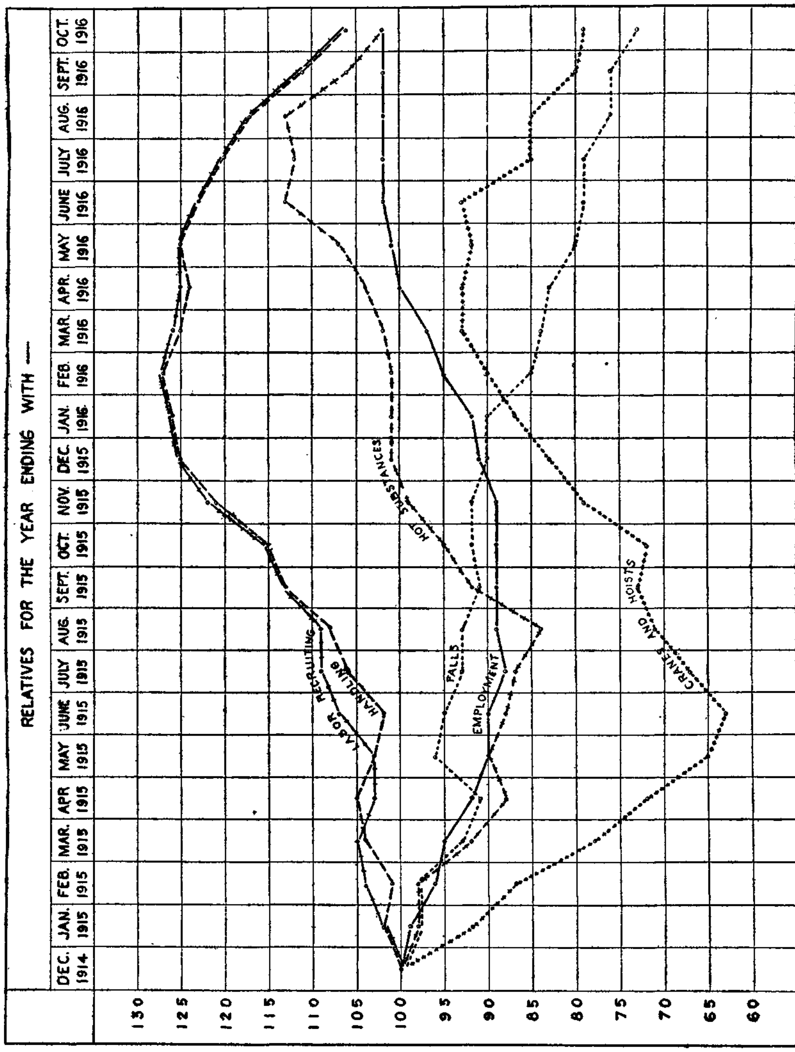
It may be repeated that this method of indicating the trend of events gives a much more sure and satisfactory indication of the changing conditions than it is possible to secure by charting the individual months.

CHARTING ACCIDENT CAUSES.

The foregoing gives an idea of the application of smoothed curves to the departmental rates. In a precisely similar manner the rates for accident causes may be computed and charted. This application is illustrated by Chart 60.

Whenever the curves for different items fall in widely separated parts of the scale, difficulty is encountered both in the matter of space occupied and in the comparison of the curves. In Chart 60, this

CHART 60.—TREND OF ACCIDENT RATES IN PRINCIPAL CAUSE GROUPS.



difficulty is overcome by reducing the rates which are charted to index numbers based upon that of the initial year taken as 100.

In this chart, the handling of objects and tools and three other causes are plotted. For comparison with these cause curves the course of employment and the new-man accession rate are also plotted. A very close and significant parallelism appears in this chart between the curve representing the new-man accession and the curve representing the handling of objects and tools. In fact they run so closely together in parts of their course that it is difficult to discriminate one from the other.

It has often been noticed that the accession of new men is almost invariably accompanied by rising accident rates, both frequency and severity. Chart 60 gives an idea of the kind of injury which these new men suffer to a specially noticeable degree. It is very likely that a man entering upon service will first be given some work involving the handling of objects or tools, and it is evident that his inexperience reveals itself in an unusually large number of injuries connected with such handling.

Among the cause groups shown by this chart are hot substances and cranes and hoists. These are known to give rise to a relatively high degree of severity. When, therefore, from the year ending in June, 1915, to the year ending in June, 1916, one or both of these causes shows a rise proportionate to or exceeding the figures of employment, it becomes evident that the safety man should give these causes particular attention.

Over the period mentioned the general tendency of all causes is upward, coincident with the rise of the new-man accession rate, to which attention has been called. There is one notable exception to this rule. The curve representing "falls of the worker" declines throughout most of the period. Special inquiry was made as to any condition which might have influenced the course of this curve, and it was found that a very active campaign was in progress for the improvement of the condition of the plant in respect to cleanliness, the condition of stairways and ladders, and the correction of other conditions likely to influence the occurrence of falls. The plotting of this curve revealed to the management for the first time the degree to which their efforts had been successful and also showed that other causes which had not been subjected to special effort had at the same time rising curves.

By the use of colored pencils it is possible in charts prepared in the same manner as those just described to introduce and to discriminate satisfactorily a very considerable number of departments or of cause groups. If such charts be maintained from month to month the trend of accident occurrence will be satisfactorily shown with scarcely more application of time and effort than that necessary to plot the ordinary monthly summary.

The cause chart, such as that described, is particularly useful in determining whether special efforts in certain directions are proving effective.

The charts just presented are plotted upon an arithmetic scale. In these particular instances the objections to the use of such a scale which are brought out later (see page 305) do not seriously apply. The charts convey in a fairly satisfactory manner the ideas which they were intended to convey. It remains true, however, that these charts would be materially improved if they were projected upon a percentage scale such as will now be described.

THE RATIO CHART.[2]

It has already been pointed out that when it is desired to compare absolute magnitudes a bar chart with the bars placed horizontal is much to be preferred. As will be amplified somewhat a little later, conclusions based upon such charts with regard to the rate at which change is taking place, and especially with regard to comparative rates, are almost certain to be erroneous. For the expression of changing relations other graphic methods are essential: The difference between the relation of absolute magnitudes and the rate at which change is occurring may be illustrated by the case of the city having in each of three enumerations a population of 50,000, 75,000, and 100,000. The relation in the matter of absolute magnitudes would be determined by noting the arithmetic difference, namely, 25,000, between the first and second, and the same number between the second and third. If, however, the interest is in the rate at which change has been occurring it would be expressed by the percentage difference between these populations. In the interval between the first and second enumeration the population increased 50 per cent; between the second and third enumeration the increase was 33⅓ per cent.

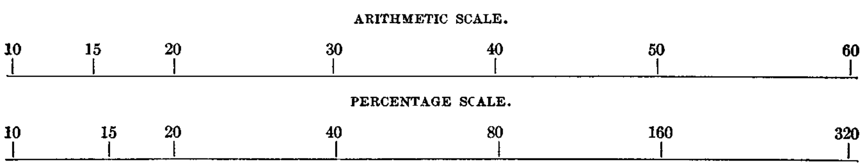
The arithmetic differences noted direct attention to the absolute magnitudes, while the statement on the percentage basis calls attention to the rate of change.

A COMPARISON OF SCALES.

It has long been a matter of interest to have a method by which the ordinary expression of rate of change, namely, an increase or decrease of so many per cent, could be expressed graphically. This result is accomplished perfectly by the use of a "ratio" chart constructed on a "percentage scale."

Since the percentage scale is derived from a consideration of the logarithms of the numbers denoting the absolute magnitudes, the scale is frequently called "logarithmic."

The fundamental characteristics of each scale will be brought out by comparison of the following form:



In the arithmetic scale shown above equal linear distances represent equal arithmetic differences. In the percentage scale equal linear distances express equal percentage differences. The arithmetic scale is so constructed that each space contains 10 units. In the percentage scale one space represents 100 per cent difference.

[2] Since the publication by Prof. Irving Fisher, of Yale University, in the July, 1917, issue of the publications of the American Statistical Association, the ratio chart has been utilized by a number of statisticians for the purpose of conveying ideas regarding the rate of change occurring in statistical magnitudes over a period of time.

Suppose that it is desired to introduce some intermediate numbers between 10 and 20 on the arithmetic scale. The space between the two would be divided into 10 equal parts, 11 would be one unit removed from 10 while 15 would be midway between 10 and 20, since points having equal arithmetic differences are always equidistant.

It is a more complicated matter to construct a complete percentage scale because any magnitude compared with an ascending or descending series of magnitudes is a constantly changing percentage. To illustrate, from 100 to 110 is 10 per cent increase; from 200 to 210 the increase is 5 per cent. Therefore on the percentage scale the linear distance from 200 to 210 will be less than from 100 to 110. As a result, in passing up the percentage scale the numbers separated by the same arithmetic difference will draw closer and closer together on account of the decreasing percentage difference.

If it is desired to locate an intermediate number, such as 15 between 10 and 20 on the percentage scale, it will be necessary to determine the logarithms of 10, 15, and 20 and then place 15 between 10 and 20 in a position representing the relation between its logarithm and the logarithms of these two numbers. When the point 15 is thus located, it will be found that it is not equally distant from 10 and 20 as is the case in the arithmetic scale but is nearer to 20, as shown. This accords with the statement already made, that a given magnitude is a constantly decreasing percentage of an increasing series of magnitudes.

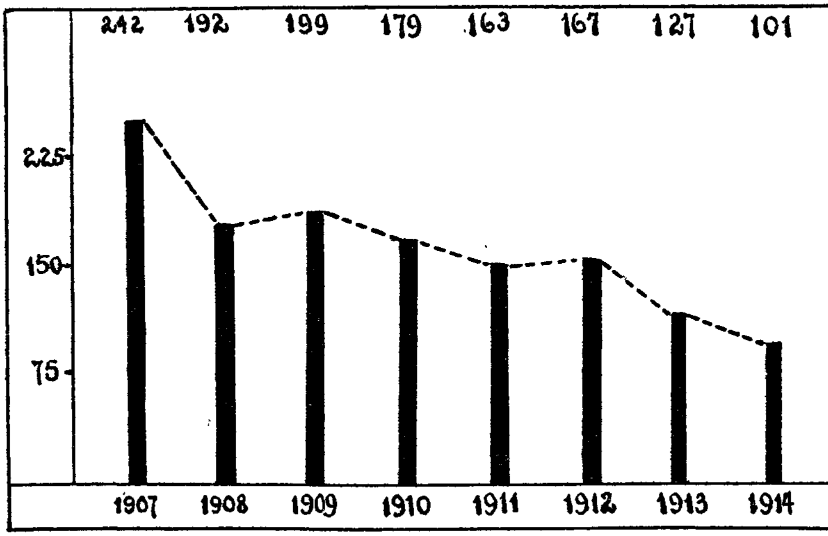
To produce percentage scales by this method of getting the logarithms from the tables would be a somewhat laborious and time-consuming process. Practically this may be avoided by using scales already prepared. There are on the market papers ruled on the percentage basis, commonly known as "logarithmic paper." From them it will usually be possible to select a scale of dimensions suited to the particular graph which it is desired to produce. In case no paper is available having satisfactory dimensions, it is easily possible to derive a usable scale, or the divisions on an engineer's slide rule may be utilized for the production of appropriate percentage scales.

ERRONEOUS USE OF ARITHMETIC CHARTS.

Before proceeding to present the characteristics and use of the ratio chart more in detail, it is desirable to show wherein the ordinary arithmetic scale fails to convey correct impressions. Much the most common and also the most deceptive of such charts is the line chart projected on an arithmetic scale.

Chart 61 is a combination of bar chart with the line chart. In it the bars are placed vertical instead of horizontal and a so-called curve is formed by introducing a line connecting the points at the ends of the bars.

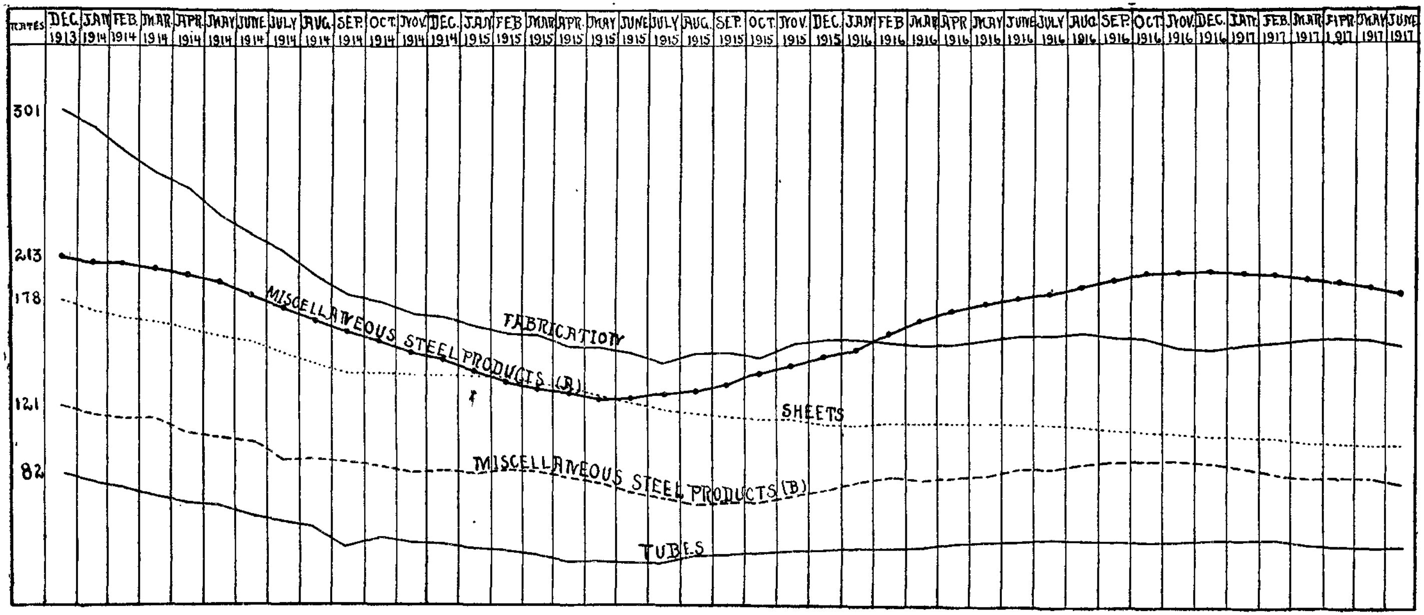
CHART 61.—COMBINATION OF BAR AND LINE CHART TO SHOW INCORRECT USE OF ARITHMETIC PLOTTING.



The only things which are properly comparable in a chart such as this are the distances from the base line to the points determined; in other words, the length of the bars. The connecting line, by which the points at the ends of the bars are united, diverts attention from the appropriate comparison to a consideration of the line itself. If, as is usually the case, the bars are not introduced, the gradient of the line between the different points becomes the basis of judgment and all idea of the distances from the base as the objects to be compared is lost. It is almost inevitable, under these circumstances, that the line will be erroneously interpreted as expressing the rate of change. This rate, however, as will be explained later, can be accurately represented only by a ratio chart in which percentage differences and not arithmetic differences are plotted.

It happens quite frequently that for some distance above the zero line no points in the curve occur. In such a case it is a common practice to omit entirely that portion of the scale. This at once and completely renders impossible the only proper comparison. Suppose the smallest magnitude in a given group is 75 and the largest magnitude is 100. It would then be in accordance with the common practice to cut away the lower portion of the scale to 70, for example. The ocular comparison of the two magnitudes will, of necessity, be that between 5 and 30 and not that between 75 and 100. This is true because the eye judges not by the figures to which the points correspond but by the distance of the points from the base line. An arithmetic chart, then, in which the scale does not extend to zero is useless or positively deceptive. Furthermore, when the series of magnitudes which it is desired to compare become increased beyond two or three, it becomes difficult, even impossible, to compare the distances from the zero line even though the entire scale be given. Further to complicate the situation by an abbreviated scale is to multiply obscurity by deception. Chart 62, based upon data assem-

CHART 62.—ARITHMETIC PLOTTING OF ACCIDENT FREQUENCY RATES.



bled by the Bureau of Labor Statistics in its studies, is the usual arithmetic projection of the experience of plants producing various steel products.

This chart has all the confusing and deceptive features specified above; namely, (1) the abbreviated scale, (2) confusing multiplicity of items, and (3) the guide lines diverting attention to themselves from the proper comparison. To test its deceptive capacity a large number of people were requested to state the impression conveyed to them by the curve for fabrication as compared with that for tube manufacture. Practically all were agreed that in the earlier years covered by the chart conditions improved more rapidly in fabrication than in tube manufacture. Only one person called attention to the fact that the omission of the lower portion of the scale made impossible the only valid comparison which such a chart should make possible. It developed constantly that the judgment rested upon the relative steepness of the gradients of the two lines.

To be correctly interpreted the line must be a true curve representing the rate of change. The so-called curves in this chart are not really curves at all but are really guide lines which the eye may follow from point to point. It is already noted that when a given point is reached the line must be forgotten while the real comparison is made of the relative distances from the base line. In practice it is entirely impossible to ignore the guide lines and give attention to the really valid comparison. The need for some form of charting from which the rate of change can be correctly judged becomes strikingly apparent. This need is fulfilled by the ratio chart.

Chart 63 has the same data plotted in ratio form. It will at once be seen that while the arithmetic chart showed the line of tube manufacture as almost horizontal, this chart shows that the rate of change in tube manufacture was greater than that of any of the others.

CHARACTERISTICS AND USE OF RATIO CHARTS.

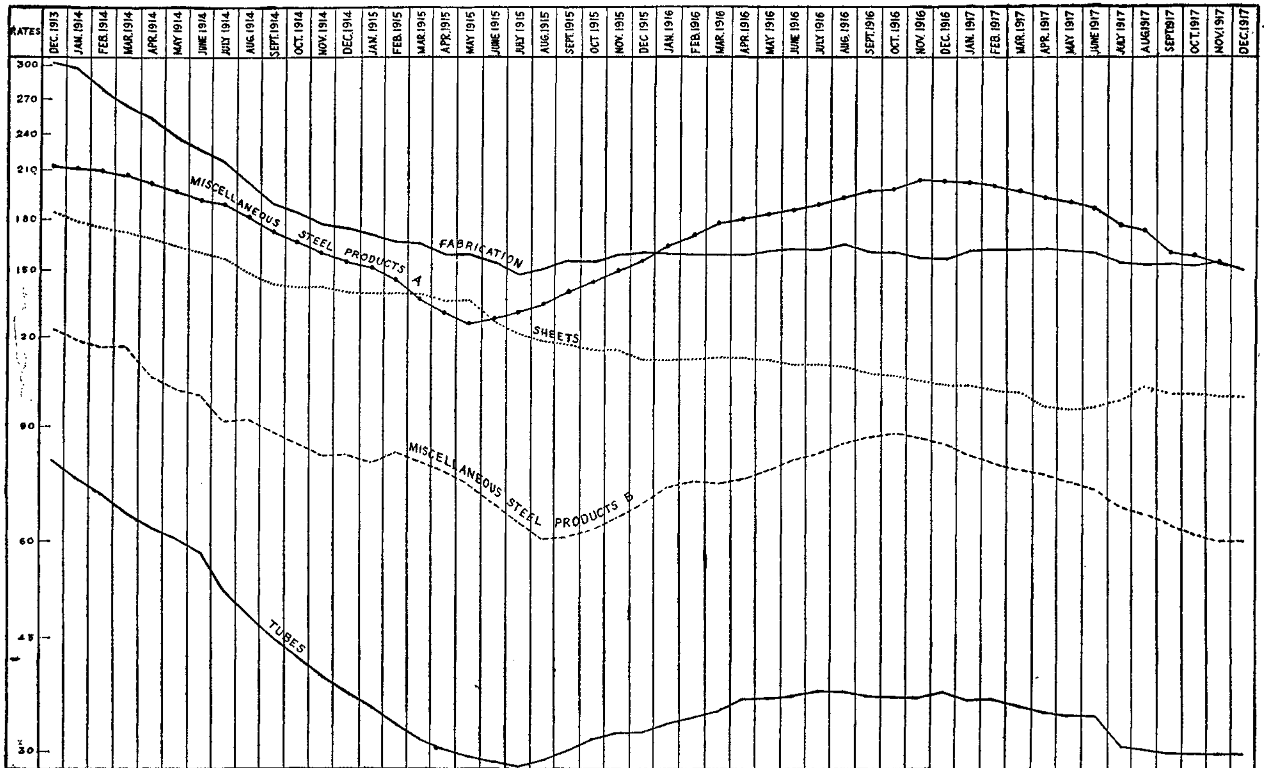
To recapitulate the points thus far made: (1) Comparison of arithmetic differences is best accomplished by means of the horizontal bar chart; (2) The arithmetic line chart is unsatisfactory because it does not clearly express its arithmetic differences and because it functions erroneously and deceptively as an indicator of rate of change; (3) An accurate conception of rate of change can be conveyed only by a ratio chart.

The ratio chart is, as has been noted, one in which magnitudes are plotted on a percentage scale. After the scale is worked out the steps in the production of the chart are precisely the same as those in an arithmetic chart. A point on the chart is determined in accordance with the scale adopted for each item in the table and the points pertaining to each particular series of magnitudes are then connected by distinctive lines. The result is to give true curves whose direction and the rapidity of whose rise and fall are the significant matters.

There are four important characteristics and functions of the ratio chart which should be pointed out:

(1) In a ratio chart a given linear distance on the scale always represents the same percentage of difference. For example, the distance from 10 to 20 (100 per cent) is precisely the same as the distance from 100 to 200.

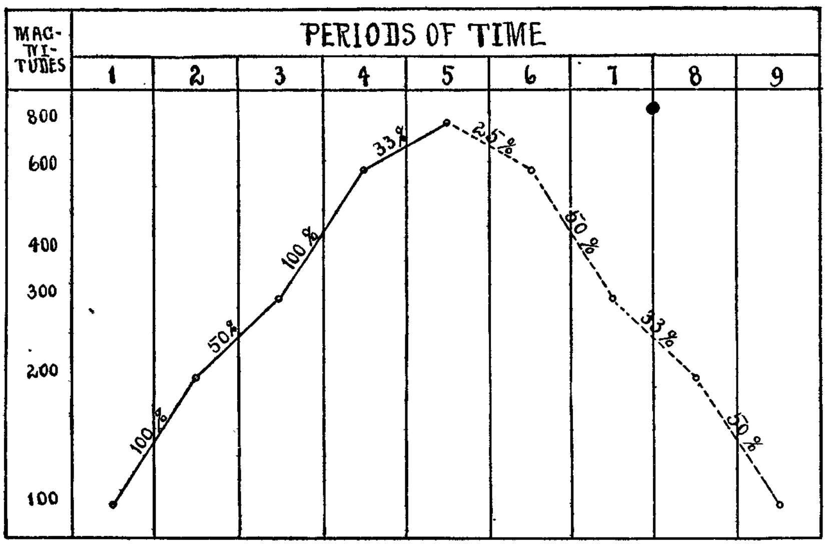
CHART 63.—A "RATIO" CHART OF THE DATA SHOWN IN CHART 62.



(2) The gradient of the lines always and necessarily expresses the rate of change in the series of statistical facts being charted. Equal rates of change or equal percentages of difference will have the same gradients. For example, if one magnitude increases from 10 to 11 while another increases from 100 to 110 the curves corresponding to the change will be parallel, indicating the fact that the rate of change is the same. Plotted on an arithmetic scale the curve from 10 to 11 would represent one-tenth of the rise of the curve from 100 to 110.

(3) A percentage scale has no zero. This is necessarily true because when there are magnitudes that are plottable, no matter how small, the percentage decrease can never be 100, and thus can never reach the zero point. An arithmetic scale in order to afford correct information must extend to zero, since the only properly comparable things are the distances from the zero line. It is a misapprehension to think that the absence of zero in the percentage scale is a disadvan-

CHART 64.—CHART ILLUSTRATING INCOMPARABILITY OF PERCENTAGES OF INCREASE AND DECREASE.



tage. The particular significance of the scale is related to this fact. Since there is no zero no attention need be given to the question of distances therefrom. It is the relation of the magnitudes to each other which is the proper subject of consideration.

(4) The ordinary terms used to express rise and decline, such as a 50 per cent rise followed by a 25 per cent decline, are really unintelligible. The fact that they convey no exact and satisfactory meaning is rarely recognized by those who use them. Comparatively few persons are instinctively aware of the fact that an increase of 100 per cent is exactly balanced by a decline of 50 per cent. Percentages of increase can be properly compared with other percentages of the same sort and percentages of decline are similarly comparable, but no direct comparison can be made between the percentage of increase and the percentage of decline. Chart 64 illustrates the fact that the two series of percentages are incomparable.

For purposes of illustration a series of nine magnitudes have been plotted; namely, 100, 200, 300, 600, 800, 600, 300, 200, 100, each regarded as occurring in successive equal intervals of time. It will be noted that the absolute decreases are in exact reverse order of the increases. The percentage decreases, however, by no means coincide with the corresponding percentage increases. Thus from 100 up to 200 is an increase of 100 per cent, while from 200 down to 100 is a decrease of 50 per cent. From 200 up to 300 is a 50 per cent increase, while from 300 down to 200 is a decrease of 33 per cent. From 600 up to 800 is a 33 per cent increase; from 800 down to 600 is a 25 per cent decrease. Any comparison of such increasing and decreasing series is impossible except by a memory of relations quite beyond the powers of the ordinary mind or by mathematical adjustments in each case so time consuming as to be out of the question. The incomparability between increasing and decreasing series of magnitudes is due to the necessary shifting of bases whenever there is a change from increase to decline or the reverse. For example, going up from 100 that number is the base and 200 is reached by a 100 per cent step. Declining to the former level, 200 becomes the base and 100 is reached by a 50 per cent step. It is evident that in any case where there is frequent reversal the tangle of incomparable percentages will be entirely unintelligible.

The ratio chart untangles these incomparables and presents the facts directly and accurately and in a form understandable merely by inspection.

SPECIAL APPLICATIONS.

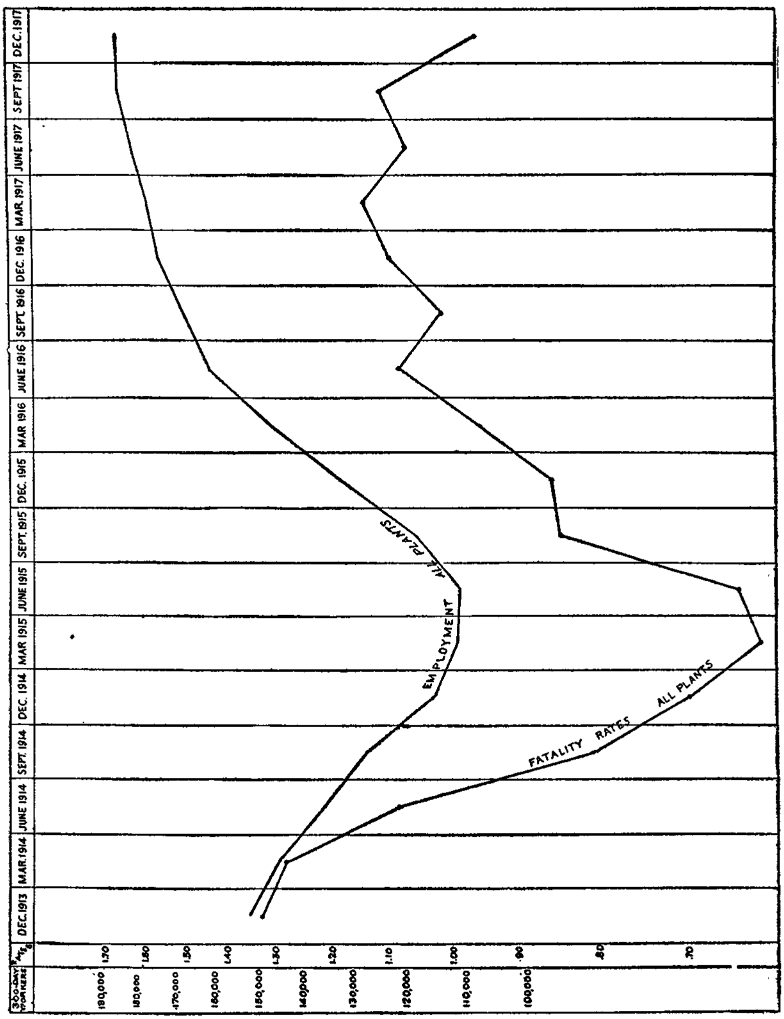
It is frequently desirable to compare series of magnitudes which fall in widely separate portions of the scale. To do this in the manner shown in the preceding charts sometimes requires an immense amount of space or the curves may be so far separated from each other as to render satisfactory comparison difficult.

Chart 65 illustrates a method of overcoming these difficulties. Two portions of the scale are placed side by side and so adjusted that the initial point of each curve falls at or near the same point. That the scales used in the chart are portions of a single scale is demonstrated by noting that the distance from 1.00 to 1.10 is the same as that from 100,000 to 110,000, 10 per cent in each case. If the scale were extended to accommodate these extremes, both the size of the paper necessary and the distance apart of the two curves would render that method of plotting out of the question. The marginal numbers which appear on this chart afford some indication of the arithmetic relations between the magnitudes, but this information is more satisfactorily secured by reference to the tables on which the chart is based. The number of curves which can be adjusted in this manner is limited. It would probably not often be justifiable to thus arrange more than two.

Whenever the degree of fluctuation is the matter of chief interest and the number of curves which it is desired to compare is considerable, the method illustrated by Chart 66 has a field of usefulness.

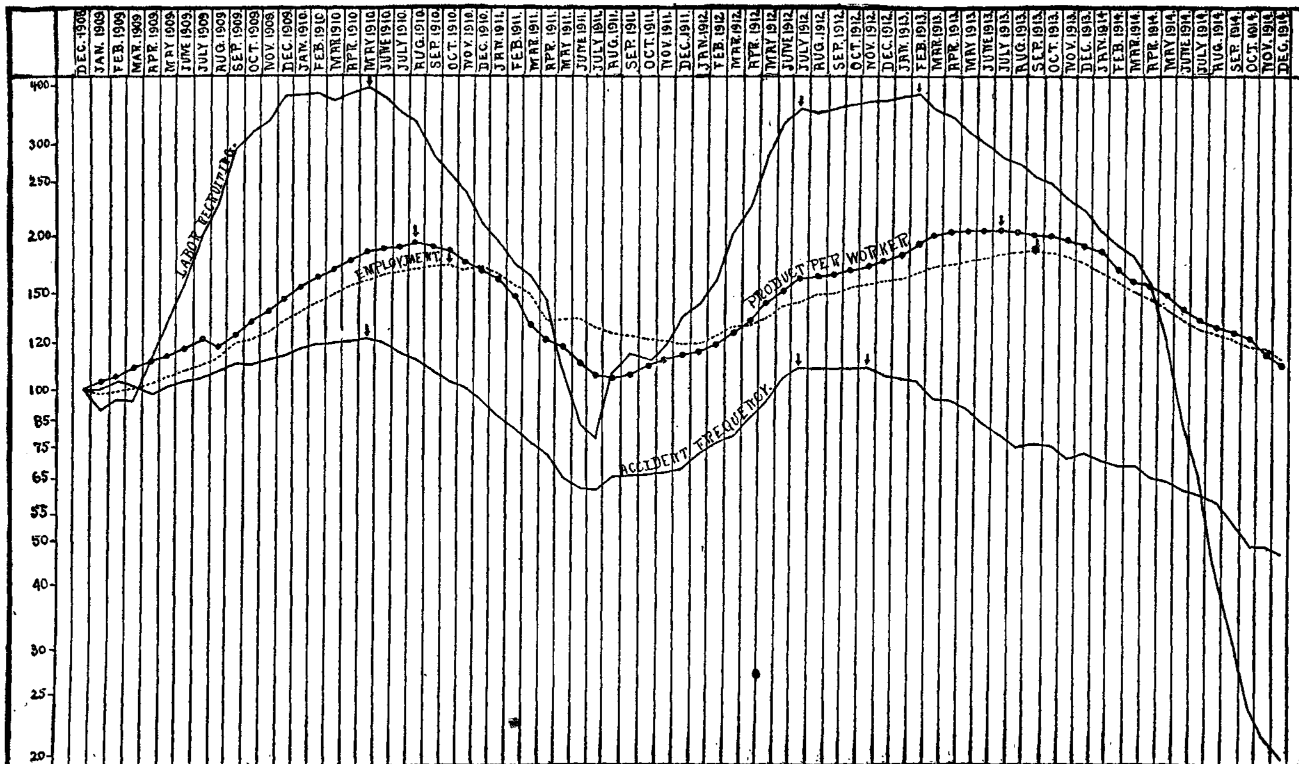
The magnitudes in these series are reduced to index numbers, those of the initial year being regarded as 100. Each curve, as a

CHART 65.—EMPLOYMENT AND FATALITY RATES IN THE IRON AND STEEL INDUSTRY ADJUSTED FOR COMPARISON.



result, starts from the same place. This procedure entirely eliminates from the chart any hint of the relative size of the magnitudes involved and confines the chart to showing the relative changes which have occurred during the period considered.

Chart 66.—COMPARISON OF THE TREND OF SEVERAL RELATED ITEMS BY "SMOOTHING," REDUCING TO INDEX NUMBERS AND PLOTTING ON A PERCENTAGE SCALE.



It may be urged that the treatment described above is not suited to the use of a busy safety office, where the chief concern must be to guard against future accidents rather than to make elaborate studies of those which have already occurred. Two things may be said regarding such a contention: (1) The safety man needs to understand, even if he does not use, the statistical devices by which the attempt is made to interpret the facts in such a way as to give the best possible insight into preventive measures; (2) the safety man will find that many of the procedures outlined are much less complicated than they appear and that they can be used currently quite as readily as some that are apparently much simpler.

It will be agreed at once that extended analysis and presentation are the proper function of national and State bureaus charged with responsibility concerning accident problems. The safety man may very well insist that he be provided with much more extensive and careful expositions than have hitherto been made for his benefit. Until his needs are more fully met by such agencies, he will find it worth his while to examine from time to time his own experience with the aid of any method which experience has shown to have significance.

APPENDIX.

(DATA UPON WHICH REPORT IS BASED.)

TABLE 1.—HOURS OF EXPOSURE IN PLANTS IN THE IRON AND STEEL INDUSTRY FURNISHING RECORDS OF INDIVIDUAL CASES, 1915 TO 1919, BY DEPARTMENTS.

Department.	1915	1916	1917	1918	1919	Total.
Blast furnaces	6,806,374	8,589,306	10,284,443	9,721,417	17,460,009	52,861,549
Bessemer	1,456,833	2,429,522	3,174,195	2,694,484	6,594,672	16,349,706
Open hearths	8,921,814	11,312,621	12,008,801	10,399,282	18,932,450	61,574,968
Foundries	2,055,798	2,771,841	3,038,145	1,937,[illegible]2	20,863,694	30,666,680
Heavy rolling mills	12,385,781	17,131,436	17,356,877	18,620,792	15,875,557	81,370,443
Plate mills	6,363,272	7,397,487	8,575,644	10,127,938	11,669,132	44,133,473
Tube mills	4,389,775	6,792,073	6,310,848	6,310,848	9,990,534	33,794,078
Fabricating	4,994,922	5,528,341	5,653,286	6,248,511	10,906,342	33,331,402
Electrical	1,258,863	1,914,055	2,138,537	2,064,173	5,196,490	12,572,118
Mechanical	4,311,926	10,129,008	11,241,895	12,365,722	36,205,585	74,254,136
Yards	3,531,473	6,478,753	5,662,545	4,791,503	8,994,087	29,458,361
Sheet rolling mills	2,145,520	3,520,712	2,860,827	2,669,097	6,564,120	17,760,276
Miscellaneous	13,007,553	15,696,839	14,864,512	19,227,851	103,804,595	166,601,350
Total	71,629,904	99,691,994	103,170,555	107,178,820	273,057,267	654,728,540

TABLE 2.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY ACCIDENT CAUSE.

MACHINERY.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Prime movers and power transmission:													
Steam engines	11	2			13	2		4		1	3		8
Internal combustion engines	2								3	1			1
Dynamos and motors				1						3			1
Shafts	1	1			2								7
Set screws, keys, and bolts													2
Belts and pulleys												1	1
Working machines:													
Bending rolls									7				
Bolt and nut machines									3		1		1
Boring mill									2		10		3
Charging cars			22							1	3		7
Charging cranes					2	3	1						
Doublers								3					
Drill presses	4		3	5					5	4	34		14
Drills, portable, electric				1						1			1
Drills, portable, pneumatic			1		1					2	2		2
Forging hammers	3		1				1		5		55	1	62
Grinding wheels	4	1	2	40	15	2		1	13	6	46	1	52
Hot and cooling beds					5	1							7
Lathes, general	4	1		2	1	1	2		8	5	103	1	43
Lathes, turret				1									
Lathes, wood									1		3		
Millers									1	1	1		2
Mud gun	8												
Planers, metal	3								3		11		3
Planers, wood									5		10		1
Presses, punch				1	3		2		37		9		16
Presses, stamping				1							1		4
Pushers						1	5						
Reamers	1						2		44		4		3
Riveters	1						1		25		5		3
Rolls			1		26	2		25	2		2		49
Roll tables					25	8					5		11
Saws, band									2		2		1
Saws, crosscut	1			1					1	1	4	1	3
Saws, metal					14	1	1		1	1	2	1	5
Saws, rip	3			1	1				7		8		6
Shapers			1		1				4	1	9		
Shears		1	7	3	17	47	1	15	19	1	21	11	84
Slotters											6		

Straighteners			1		11								5
Tappers							2						
Threaders	1						21				1		
Transfer tables						1							
Tube drawing benches							3						
Forging press													3
Other machinery:													
Elevator accidents	1	1	1		1				1	2		1	3
Crane, caught by chain hooks	21	10	115	91	66	83	9	3	80	1	43	9	157
Crane, cable catching person	1	1	5	2	7	1					1		2
Crane, load swinging	15	15	72	44	64	75	9	3	47	1	32	20	132
Crane, load lowering	4	2	20	16	27	23	5	3	60	1	16	6	48
Crane, load falling	6	3	57	46	42	70	11	11	74	2	49	12	124
Crane, load falling, broken machinery			1		4	2					1	2	2
Crane, load falling, hitch slipped	3		6	2	5				6		2	3	5
Crane, objects falling from crane	1		15	5	15	6	1		6	2	5	2	21
Crane, falls from crane or truck		2	4	1	4		1		2	7	2		1
Crane, other accidents	27	9	52	42	56	32	14	2	28	19	45	11	103
Derricks and hoists	1				1					1			1
Blocks and tackles, windlasses, etc.	7		2	2	1	2					7		6
Conveyors	1		1	1	4	1					1		5
Gantry cranes	1								3		2		1
Locomotive cranes	2		4	1	1	1							7
Pumps	1		1		2				1		2		4
Fans and blowers									1				
Unclassified	14	5	8	14	15	7	27	3	25	11	69	18	178
Total	153	54	403	324	452	372	119	73	529	76	638	101	1,211

VEHICLES.

Steam and electric railways:													
Train wrecks, collision	1											7	3
Train wrecks, derailment			1									5	4
Falls, getting on or off, in motion	5		6		2				1		1	27	9
Falls, getting on or off, at rest	15	2	23	1	9	2	1		3	1	7	45	38
Falls, riding on, sudden start or stop	4		1		1						1	6	1
Falls, riding on, slipping, or lost balance	6		1				1		1			5	3
Falls, riding on overhead structure	1		1										
Falls, riding on, side structure	1		1									2	
Falls, not otherwise classified	3		5						1		1	6	
Struck by or caught between cars	20	10	31	2	16	4	3			1	9	56	7
Coupling or uncoupling	6	18	55	1	8	1			2	1	4	165	36
Switching	6	1	6		1				1	1	2	50	15
Repairing track												1	
Crossing track			1		1							4	1
Standing or walking on track			1		2							1	
Setting or releasing hand brakes	4			1								6	
Objects falling from	14	4	19	9	9	5		1	2	1	4	28	27
Other accidents	42	7	20	2	1	3	2			1	4	46	17

TABLE 2.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY ACCIDENT CAUSE—Continued.

VEHICLES—Concluded.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Auto vehicles:													
Collisions with other vehicles	1										1		5
Cranking				1					1		2		8
Struck by		2			1	1	1				6		4
Objects falling from			1	1									
All other	2	1				1							2
Unclassified	18	4	29	3	10	3	1		1	1	10	27	26
Total	149	49	202	21	61	20	9	1	13	7	52	487	213

HOT SUBSTANCES.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Explosives:													
Transportation and handling	1												
Blasting	1												1
Dust			2										
Gas			2								1		3
Other	1					1					2		
Electricity:													
Short circuits at switches	12		22	6	27	20	1	1	3	53	12	1	26
Contact exposed conductors	8		5	1	7	7	1			22	15	2	5
Other	10		6	3	9	8				26	13	2	21
Conflagrations	1					1				2			1
Hot substances and flames, asphalt, etc.:													
Liquids, water	15	1	30	1	10	7	3			3	17	5	44
Other liquids			3		2				1				6
Metal, falls on sheets						1		21					8
Metal, handling sheets								2					1
Hot bars in rolls			1		10	1	5		1				75
Hot scale		2	6	2	19	10	3	2	6		6	2	29
Hot stock ejected	1											1	
Molten metal, breakouts	6		33										5
Explosions	25	9	37	15	6	4	3			1	3	1	9
Ingot explosions		19	18	1									
Sparks and splashes	188	70	285	73	40	19	12	3	5	6	12	13	55
Spills	1		5							1			3
Slag, other	21		27	7	3	2	1					1	1

Steam	30	4	22	3	10	5	1	1	1		15	5	32
Flames	46	8	109	12	24	10	4	1	6	6	34	3	79
All other	56	7	159	40	66	62	12	7	15	2	44	12	174
Corrosive substances	6		1	2	1	1	4		2		6		52
Unclassified	7		8	4	11	3	4	1	1	2	4	3	14
Total	436	120	781	170	245	162	54	39	41	124	184	51	644

FALLS OF PERSONS.

Falls of persons:													
From benches, boxes, chairs, and tables	1	1	1	1	3	1		1	1	1	4		6
From buildings, in construction or demolition	2		1	1							4		2
From cranes, derricks, or hoists in erecting or rigging													1
From ladders	14	2	14	6	14	4	1		6	20	21	1	38
From piles	1	1	4	1	3	3	2		1		3	2	13
From poles and trees										3			
From roofs	1		2		1					3	6	1	5
From runways, balconies, and platforms	8	6	22	2	6	2		1		3	16	3	17
From scaffolds or staging	23	6	11	1	5	4	1		12	4	41	3	14
From stairs	13	4	11	4	11	1			4	3	10	2	17
From tramways and trestles	4											2	
From other elevations	21	3	27	7	23	7	1	1	16	5	32	6	37
Into bins and vats	13		4	1	1				1				5
Into floor openings	4	1	21		10	7	5	2		1	9	3	17
Into manholes	2		4		3	4		1		1	2	3	2
Into excavations	4	1	11	2	3	1					3	3	14
Due to slipping on level	53	14	89	21	66	58	17	23	35	16	80	20	221
Due to stumbling on level	24	4	30	22	32	14	6	10	11	5	25	20	78
Other falls	11	4	30	8	23	14	5	1	7	8	28	4	60
Total	199	47	282	77	204	120	38	40	94	73	294	73	547

TABLE 2.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY ACCIDENT CAUSE—Continued.

FALLING OBJECTS.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Collapse of scaffolds or staging	1		2							1	5		1
Falling objects:													
From buildings	1		2	1	2	1		1	2	1	5	1	4
From chutes, conveyors, or slides	7		6		1						4	2	1
From machines or work benches	2		4	9	12	24	4	1	15	1	37	3	47
From piles	21	10	37	17	34	16	8	13	21	2	20	25	104
From racks and shelves	3		1	2	4		2		2		3		13
From runways, balconies, etc	1		1								1		1
From scaffolds and staging	1		4			1			2		8		7
From temporary floors													
From tramways and trestles	2				3		1						5
From other elevations	94	34	194	74	114	186	28	7	65	16	188	34	327
Cave in of ditches				1			1				1		1
Objects tipping over (not vehicles)	49	21	95	131	138	73	20	17	87	11	108	36	353
Other falling objects	8	4	15	4	8	1		1	3		4	3	11
Total	190	69	361	239	316	302	64	40	197	32	384	104	875

OBJECTS AND TOOLS BEING HANDLED.

Accident cause.	Blast furnaces.	Bessemer.	Open hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet rolling mills.	Fabricating.	Electrical.	Mechanical.	Yards.	Unclassified.
Objects dropped in handling	160	40	305	106	214	215	49	41	97	10	301	99	719
Caught between object handled and other object	69	25	121	138	129	83	41	20	85	12	149	38	380
Lifting causing strain	89	8	125	72	100	94	26	24	27	14	138	53	366
Handling glass	2			3	2				1	2	2	1	5
Handling sheet metal			2		2			197	1		7		103
Handling objects with protruding nails	2		2	8	2	1			1		4	1	3
Handling other sharp objects	40	9	74	30	33	90	25	4	12	9	68	14	205
Handling trucks or barrows, collide with person		2	1	1				1			3		4
Handling trucks or barrows, collide with objects	3	1	3	1		1	3				1		5
Handling trucks or barrows, overturn	18	4	16	1	2	3	1	1	3		5	6	25
Handling trucks or barrows, objects fall from	3	5	6	12	8	3	3	2	2	1	9	5	46
Handling trucks or barrows, other accidents	7	5	16	9	11	10	9	4	9	6	28	10	134

Tools in hands of worker:													
Glance or slip	118	21	103	73	188	88	35	51	79	20	189	38	419
Break or come apart	7		10	7	5	4	4	7	1		18	1	15
Objects fly from, not otherwise specified	21	4	23	15	15	5	2	1	13	1	27	10	38
Objects fly from nails and spikes				1	2				2		1		1
Objects fly from metal chips	7	1	9	55	20	2	7		28	4	54	8	44
Objects fly from stone or cement	2		1		1		1				4		3
Tools in hands of fellow worker:													
Glance or slip	24	3	34	9	19	9	4	10	14	5	51	9	62
Break or come apart	3		6	4	1	1	2	1	4		4		8
Objects fly from, not otherwise specified	3	1	1		4	2		1	6		7		4
Objects fly from nails and spikes													2
Objects fly from metal chips			1	1	3		2		19	2	9	1	5
Objects fly from stone or cement			1								1		1
Unclassified	6	3	21	6	19	10	7	27	5	2	9	6	55
Total	584	132	881	552	780	621	221	392	409	88	1,089	300	2,652

MISCELLANEOUS.

Asphyxiating gas	76		27	1	1				1	1	22	2	19
Cold	1				1				1		1		3
Doors, windows, etc	1	1	1	3	2	5				2	7	1	10
Drowning									1				1
Flying objects, not otherwise classified	202	53	178	144	137	63	53	15	194	30	250	99	299
Heat	4	1	17	2	11	16	7			5	6	4	40
Nails and other sharp objects stepped on	14		33	31		23	4		23	11	61	6	80
Violence	1		4	1	1	3		1					13
Striking against objects	37	15	85	35	62	91	35	94	36	15	90	29	250
Uneven footing	45	12	84	19	56	23	2	10	21	20	66	30	149
Moving objects, not otherwise classified	13	5	12	15	33	55	13	7	23	2	21	8	98
All other	20	4	11	15	27	9	3	3	1	3	25	6	56
Total	414	91	452	266	331	288	117	130	301	89	549	185	1,018

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY.

BLAST FURNACES.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	3		2	56	1	2	25	195	284
Skull	5	1	4	2	5	5	2	2	26
Other parts of head	7		9	18	12	22	13	13	94
Face and neck	4		9	68	14	4	20	12	131
Trunk:									
Back	1		5	17	17	9	65	3	117
Vertebrae	1								1
Thorax	5		21	12	22	3	16	5	84
Abdomen	3		5	3	3	1	4	1	20
Groin	1		2		2		11		16
Pelvis	1		2						3
Generative organs					3		4		7
Upper extremities:									
Clavicle					2	2			4
Shoulder	4	1	4	6	8	4	4		31
Upper arm			4		1		1		6
Elbow			1	3	8	2	4	3	21
Ulna			1		1				2
Radius					1				1
Ulna and radius					1			1	2
Forearm	3		1	21	8	1	6	3	43
Wrist	4		4	6	14	1	8	1	38
Hand	10		4	47	8	5	40	3	117
Both hands				20		1			21
1 finger	46		11	6	3	8	117	3	194
2 fingers	6		2	2	1	1	8		20
3 fingers	1						1		2
4 fingers	1								1
Thumb	11		2	1	1	4	27	3	49
Thumb and 1 finger				1					1
Thumb and 4 fingers						1			1
Lower extremities:									
Hip	1				5			2	8
Femur	2		1		2	1	1		7
Upper leg	6		8	9	6	3	11	5	48
Knee	6		9	4	19	4	11	6	59
Tibia			1			3			4
Fibula					1				1
Tibia and fibula	1		1			3			5
Lower leg	3		7	25	6	11	8	3	63
Ankle	4		5	24	13	8	14	33	101
Foot	9		18	64	7	51	89	28	266
Both feet				9		1		1	11
Great toe	3		4	2	2	26	69	4	110
Great toe and others	1					1	4	2	8
Other toes						2	1		3
Unclassified		1	2	10	2			82	97
Total	153	3	149	436	199	190	584	414	2,128

BESSEMER.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	2		1	20		1	3	48	75
Skull					2				2
Other parts of head	6		2	2	1	11	1	5	28
Face and neck	4			14			2	2	22
Trunk:									
Back	2			11	3		6	1	23
Thorax	4		4	9	11	1	4	1	34
Abdomen	1			4	1	1	2		9
Groin							2		2
Upper extremities:									
Clavicle								1	1
Shoulder				3	4	1	1	2	11
Upper arm				1					1
Elbow			1					1	2
Radius	1								1
Ulna and radius			1		1				2
Forearm			1	6			2		9
Wrist	1				2	1	4		8
Hand	2		1	6		4	11	1	25

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

BESSEMER—Concluded.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Upper extremities—Concld.									
Both hands				5					5
1 finger	12		13		1	3	26	2	57
2 fingers	2			1		2	2		7
3 fingers	1								1
Thumb			3			2	10	1	16
Lower extremities:									
Hip			2						2
Femur	1				2				3
Upper leg	2		2	1	2		4	3	14
Knee	3		1		3			3	10
Tibia	2								2
Fibula	1				1				2
Tibia and fibula	1		1		2				4
Lower leg	3		2	6	4	5	6	2	28
Ankle			1	6	4	3	1	10	25
Foot	1		11	21	3	13	23	5	77
Great toe	2		2			14	19	2	39
Great toe and others						1	1		2
Other toes						5	2		7
Unclassified				4		1		1	6
Total	54		49	120	47	69	132	91	562

OPEN HEARTHS.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	2			91	2	1	34	150	280
Skull	6		1			3		1	11
Other parts of head	23		9	28	20	38	16	18	152
Face and neck	21		5	181	18	4	18	8	255
Trunk:									
Back	12		7	50	15	20	97	5	206
Vertebrae			1				1		2
Thorax	22		17	31	33	8	15	12	138
Abdomen	4		2	4	3	1	9	1	24
Groin	1						7	1	9
Pelvis	2		1			1	1		5
Generative organs	1			2			1	2	6
Upper extremities:									
Clavicle	2				3	1		1	7
Shoulder	5		3	10	16	10	10	1	55
Upper arm			1	3	2		3	1	10
Elbow	2		2	3	7	1	2	2	19
Ulna			1		1				2
Radius	1		1		5		2	1	10
Forearm	4		2	42	14	5	10	7	84
Wrist	5		2	9	15	7	14	3	55
Hand	21		13	64	13	16	87	15	229
Both hands				21			1		22
1 finger	106		27	5	3	30	176	12	359
2 fingers	11		6	2	2	1	16	2	40
3 fingers	3		1			1	3		8
Thumb	18		6	7	4	8	52	2	97
Thumb and 1 finger	1								1
Thumb and 2 fingers	1			1					2
Lower extremities:									
Hip	4		2	2	5	4	2	2	21
Femur	3		1		4	1			9
Upper leg	23		11	11	8	4	10	4	71
Knee	8		6	3	22	8	14	12	73
Tibia	1				1				2
Fibula	1		1		2				4
Tibia and fibula			2		3	4			9
Lower leg	12		9	30	23	13	22	13	122
Ankle	13		12	42	28	15	17	76	203
Foot	41		40	110	8	86	129	50	464
Both feet			3	8			1		12
Great toe	19		7	5	1	62	103	7	204
Great toe and others	2					4	4		10
Other toes	2					4	4		10
Unclassified				16	1			43	60
Total	403		202	781	282	361	881	452	3,362

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

FOUNDRIES.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eyes	18			33			57	130	238
Skull	1		1				1	1	4
Other parts of head	6		2	5	3	9	8	4	37
Face and neck	9			20	3	3	10	4	49
Trunk:									
Back	8		1	2	3	6	37	2	59
Thorax	11		2	6	12	4	9	2	46
Abdomen	1			1	1	1	5	1	10
Groin					1		11	1	13
Pelvis	2								2
Upper extremities:									
Scapula	1								1
Shoulder	5				2	1	2	1	11
Upper arm	2			1		1	3	1	8
Elbow	2			1	2	1	6	3	15
Radius					1		1		2
Forearm	8			7	2	4	4	3	28
Wrist	5			3	4	1	13	5	31
Hand	18			14	4	7	52	9	104
Both hands	1			3			1		5
1 finger	85		2	2	7	14	147	10	267
2 fingers	14		1	2	1	1	12	2	33
3 fingers	1			1					2
Thumb	31		1		3	2	36	3	76
Thumb and 2 fingers							1		1
Lower extremities:									
Hip	1				2		1		4
Femur						1		1	2
Upper leg	19		1	1	4	7	6	1	39
Knee	4		2		9	6	6	6	33
Tibia	1					1			2
Fibula	1								1
Tibia and fibula	2					2			4
Lower leg	10		1	1	1	19	7	7	46
Ankle	5			16	8	13	11	21	74
Foot	25		5	42	4	78	49	37	240
Both feet				7					7
Great toe	24		2			50	52	7	135
Great toe and others	3			1		7	4		15
Unclassified				1				4	5
Total	324		21	170	77	239	552	266	1,649

HEAVY ROLLING MILLS.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	8			41		2	33	119	203
Skull	6		2		4	1	1	1	15
Other parts of head	32			23	12	10	14	13	104
Face and neck	24		1	27	14	1	41	8	116
Back	8		5	7	15	1	73	1	110
Trunk:									
Thorax	14		6	11	18	3	12	5	69
Abdomen	5		3	3	2		11	3	27
Groin	1		1		2		8		12
Pelvis	1		1		2				4
Generative organs					4		2		6
Upper extremities:									
Scapula					1	1			2
Clavicle			2		1				3
Shoulder	4		3	3	6	3	12	1	32
Upper arm	1			1	1	2	2		7
Elbow	2				5		2	6	15
Ulna					1		2	1	4
Radius					4		2		6
Ulna and radius	1		1						2
Forearm	7		1	18	2	6	9	2	45
Wrist	5			2	9	2	16	2	36
Hand	31	1	2	32	9	6	85	10	176
Both hands				14	1				15
1 finger	91		3		3	14	135	8	254
2 fingers	9			6		2	13		30

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

HEAVY ROLLING MILLS—Concluded.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Upper extremities—Concld.									
3 fingers	6	....	1	....	....	....	1	....	8
4 fingers	1	....	....	....	....	....	....	....	1
Thumb	23	....	1	2	3	6	31	1	67
Thumb and 2 fingers	1	....	....	....	....	....	....	....	1
Thumb and 3 fingers	....	....	....	....	....	....	1	....	1
Lower extremities:									
Hip	2	....	....	....	1	1	7	1	12
Femur	2	....	....	....	1	1	....	1	5
Upper leg	28	....	3	7	5	8	9	11	71
Knee	10	....	1	....	26	3	5	16	61
Tibia	....	....	....	....	....	1	....	1	2
Fibula	3	....	....	....	2	....	1	1	7
Tibia and fibula	2	....	1	....	1	4	2	1	11
Lower leg	29	....	4	7	17	17	25	11	110
Ankle	17	....	2	7	18	18	20	58	140
Foot	42	....	12	25	12	113	114	30	348
Both feet	....	....	....	5	....	....	1	....	6
Great toe	26	....	5	....	1	71	78	5	186
Great toe and others	2	....	....	....	....	5	5	1	13
Other toes	7	....	....	....	....	12	7	1	27
Unclassified	1	....	....	4	1	2	....	12	20
Total	452	1	61	245	204	316	780	331	2,390

PLATE MILLS.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	2	....	....	27	2	....	10	48	89
Skull	3	....	....	....	....	1	....	1	5
Other parts of head	16	....	2	22	6	10	....	4	60
Face and neck	13	....	1	23	3	1	22	4	67
Trunk:									
Back	11	....	1	1	12	3	58	1	87
Vertebrae	1	....	....	....	1	....	....	....	2
Thorax	9	....	....	2	20	3	14	3	51
Abdomen	5	....	....	2	3	....	6	3	19
Groin	1	....	....	....	....	1	6	1	9
Pelvis	2	....	....	....	....	....	....	....	2
Generative organs	....	....	....	....	....	....	1	1	2
Upper extremities:									
Clavicle	1	....	....	....	2	....	....	....	3
Shoulder	5	....	....	1	5	1	7	1	20
Upper arm	2	....	1	....	1	....	....	1	5
Elbow	1	....	....	....	1	1	4	2	9
Ulna	2	....	....	....	2	....	....	....	4
Radius	....	....	....	....	....	....	1	....	1
Ulna and radius	....	....	....	....	....	1	....	....	1
Forearm	9	....	2	12	10	3	19	12	67
Wrist	5	....	....	7	8	3	22	4	49
Hand	33	....	1	20	9	12	71	4	150
Both hands	....	....	....	5	....	....	....	....	5
1 finger	65	....	3	4	2	9	98	9	190
2 fingers	12	....	....	3	....	1	9	1	26
3 fingers	5	....	....	....	1	....	1	....	7
4 fingers	1	....	....	....	....	....	....	....	1
Thumb	17	....	....	2	....	4	25	8	56
Lower extremities:									
Hip	5	....	....	....	....	....	5	1	11
Femur	3	....	....	....	....	2	....	....	5
Upper leg	27	....	3	4	6	5	15	53	113
Knee	8	....	1	1	8	5	8	12	43
Tibia	....	....	....	....	....	....	....	1	1
Fibula	3	....	....	....	....	....	1	2	6
Tibia and fibula	2	....	....	....	....	1	....	1	4
Lower leg	21	....	1	2	1	15	17	8	65
Ankle	10	....	....	4	12	16	12	30	84
Foot	36	....	3	15	4	113	105	45	321
Both feet	....	....	....	4	....	2	1	....	7
Great toe	32	....	1	1	....	82	81	10	207
Great toe and others	3	....	....	....	....	1	1	....	5
Other toes	1	....	....	....	....	6	1	....	8
Unclassified	....	....	....	....	1	....	....	17	18
Total	372	....	20	162	120	302	621	288	1,885

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY CAUSE AND LOCATION OF INJURY**—Continued.

TUBE MILLS.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	8			16			13	43	80
Skull	2						1		3
Other parts of head	9				1	2	2	3	17
Face and neck	7			9	2	1	2	3	24
Trunk:									
Back	7		3	2	5	1	7	4	29
Thorax	9		1		2	1	12	2	27
Abdomen	2						5	1	8
Groin							9		9
Pelvis							1		1
Generative organs	1				1		3	1	6
Upper extremities:									
Clavicle							1		1
Shoulder					3	1	4		8
Elbow	2				1	1	2		6
Ulna							1		1
Radius			1		1		1		3
Forearm	1		1	3	2		4	6	17
Wrist	1			2	2	1	3		9
Hand	12			7	2	2	23	10	53
Both hands				3					6
1 finger	25					4	45	7	81
2 fingers	2			1		1	8	1	13
3 fingers							1		1
Thumb	8		1		1		8	4	22
Thumb and one finger			1						1
Lower extremities:									
Hip	2				1	1	2		6
Femur	1				1				2
Upper leg	1			3	2	2	3	5	16
Knee					3	3	1	4	11
Tibia						1			1
Fibula					1				1
Tibia and fibula						1			1
Lower leg	5			1	4	3	2	2	17
Ankle	3				2	3	3	3	14
Foot	7		1	4	1	23	36	9	81
Both feet				3					3
Great toe	2					9	17	1	29
Great toe and others	1								1
Other toes						3			3
Unclassified	1						1	8	10
Total	119		9	54	38	64	221	117	622

SHEET ROLLING MILLS.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	5			4			5	11	25
Other parts of head	1				2	2		3	8
Face and neck	1			3			6	5	15
Trunk:									
Back	1			3	2		12		18
Thorax					4		9		13
Groin							8		8
Upper extremities:									
Shoulder	1			1			3		5
Upper arm					2		4	1	7
Elbow					1		8		9
Forearm	3			10	3	3	45	8	72
Wrist	1			1	2		32	2	38
Hand	7			6	3		43	6	65
Both hands				3			3		6
1 finger	14					1	66	8	89
2 fingers	5						5		10
3 fingers	2						1		3
4 fingers	1								1
Thumb	2				1	1	15	2	21
Lower extremities:									
Hip	1				3				4
Upper leg	2			4			3	1	10

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

SHEET ROLLING MILLS—Concluded.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Lower extremities—Concld.									
Knee	3			1	6		19	5	34
Tibia						1			1
Fibula					1			1	2
Tibia and fibula	1					2			3
Lower leg	5			1			7	9	22
Ankle	2				9		29	22	62
Foot	11		1	2	1	23	53	44	135
Both feet	1								1
Great toe	3					7	15	2	27
Unclassified							1		1
Total	73		1	39	40	40	392	130	715

FABRICATING.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	26			13			54	185	278
Skull	4				1				5
Other parts of head	15				8	8	9	3	43
Face and neck	26		2	11	5	2	25	10	81
Trunk:									
Back	8		1				23	1	33
Thorax	12		1		12	1	9	1	36
Abdomen	4								4
Groin					1		3		4
Upper extremities:									
Clavicle	1		1						2
Shoulder	3		1		2	2	2		10
Upper arm	7			1		3	3		14
Elbow	3				7		4		14
Ulna	1					1			2
Radius	1				1				2
Ulna and radius	2								2
Forearm	8			1	1	3	3	2	18
Wrist	6				4		5		15
Hand	32		2	4	3	5	21	11	78
1 finger	162		2	2	5	21	117	15	324
2 fingers	24					6	8	1	39
3 fingers	3						1		4
4 fingers	1								1
Thumb	35			1	1	2	18	2	59
Lower extremities:									
Hip	2				2	1	1		6
Femur	3				1	1			5
Upper leg	16		1	1	7	5	3	1	34
Knee	11		1		15	2	9	15	53
Tibia	1					1			2
Fibula	4				1				5
Lower leg	16			2	4	9	8	4	43
Ankle	18				9	7	4	17	55
Foot	42		1	4	2	51	22	27	159
Great toe	26				1	59	45	4	135
Great toe and others	6					7	2		15
Unclassified				1	1			2	4
Total	529		13	41	94	197	409	301	1,584

ELECTRICAL.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	10			10		1	8	31	60
Skull	3				2				5
Other parts of head	5			34	3	1	1	1	45
Face and neck	5		1	16	5			2	29
Trunk:									
Back			1	2	5		7		15
Thorax	5			1	3		2	1	12
Abdomen	1				1		1		3
Groin					2		3	1	6
Pelvis	1				1				2

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY CAUSE AND LOCATION OF INJURY**—Continued.

ELECTRICAL—Concluded.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Upper extremities:									
Clavicle						1			1
Shoulder				1	4		1		6
Upper arm	1								1
Elbow	1			1	3	1	1	1	8
Ulna					1	1			2
Radius					1	1			2
Forearm				2	1		2		5
Wrist	2			2	7	2	2	1	16
Hand	8		1	30	3	3	10	2	57
Both hands				4				1	5
1 finger	11			3		1	23	2	40
2 fingers	2			1			2		5
3 fingers				1					1
Thumb	4			1		2	7		14
Thumb and 1 finger	1								1
Lower extremities:									
Hip	1				1				2
Femur	1								1
Upper leg	2		1	3	3		1	1	11
Knee	4				5			3	12
Fibula	1								1
Tibia and fibula					4	1			5
Lower leg	1			1	2	1	3	4	12
Ankle	1		1	1	14	1	1	18	37
Foot	4		2	5	2	13	6	12	44
Great toe						2	7	2	11
Great toe and others	1								1
Unclassified				5				6	11
Total	76		7	124	73	32	88	89	489

MECHANICAL.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	126			19		1	73	228	447
Skull	4		1		5	1	1		12
Other parts of head	15		1	10	13	41	17	21	118
Face and neck	25			42	13	4	33	11	128
Trunk:									
Back	10	1	2	2	21	7	84	5	132
Thorax	12		2		28	6	19	7	74
Abdomen	5		1	2	1	1	9		20
Groin	1				3	1	28	2	35
Pelvis	1				2		1		4
Generative organs			2	1	2		1		6
Upper extremities:									
Scapula	1						1		2
Clavicle	2				1		2		5
Shoulder	8		1	2	22	10	15	9	67
Upper arm	4			1	1	2	1	4	13
Elbow	2		1		17	4	12	8	44
Ulna					2		1		3
Radius	4		1		3		1		9
Ulna and radius	1				3		1		5
Forearm	16			13	8	5	14	3	59
Wrist	15		2	4	19	3	23	4	70
Hand	51		2	40	10	10	123	9	145
Both hands	1			7				1	9
1 finger	138			3	9	25	213	7	395
2 fingers	16		1	1		6	22	2	48
3 fingers	3						1		4
4 fingers	2				1	1			4
Thumb	48			2	5	5	62	4	126
Thumb and 1 finger	3						2		5
Thumb and 2 fingers	1				1				2
Lower extremities:									
Hip	1		2		6	1	1	2	13
Femur	1				2			1	4
Upper leg	17		7	5	14	7	20	15	85
Knee	8		3	2	23	8	25	24	93
Tibia	2		1		1				4
Fibula	2				3	1	1		7

Table 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND LOCATION OF INJURY—Continued.

MECHANICAL—Concluded.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Lower extremities—Concld.									
Tibia and fibula	6		4		1	1		1	13
Lower leg	12		3	6	12	15	16	7	71
Ankle	10		5	5	33	14	9	57	133
Foot	42		3	13	7	138	142	83	428
Both feet			1	2		1			4
Great toe	16		3	1		60	107	6	193
Great toe and others	3		1			3	5		12
Other toes	3		1			2	3		9
Unclassified				1	2			28	31
Total	638	1	52	184	294	384	1,089	549	3,191

YARDS.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	3		1	6			12	86	108
Skull	1		2					1	4
Other parts of head	7		20	3	3	7	6	4	50
Face and neck	5		9	11	5	1	8	3	42
Trunk:									
Back	3		19	2	6	5	35		70
Thorax	9		32		11	2	6	1	60
Abdomen			2			1	2	2	7
Groin			2				6		8
Pelvis			3						3
Generative organs			3					1	4
Upper extremities:									
Clavicle					1		1		2
Shoulder	2		15	1	3	2	4	1	28
Upper arm			4			1		1	6
Elbow			2			1		1	4
Ulna	1							1	2
Radius			3		1			1	5
Ulna and radius			1				1		2
Forearm	1		5	1		2	5		14
Wrist	1		7	2	4	2	3		19
Hand	3		32	5	3	2	22	4	71
Both hands			1	1					2
1 finger	16		68	2	2	4	54	4	150
2 fingers	1		14				6	1	22
3 fingers			1			1			2
Thumb	6		18		1	1	15		41
Thumb and 1 finger			1						1
Lower extremities:									
Hip	2		3			1		1	7
Femur	2		3					1	6
Upper leg	5		21	2	5	3	6	3	45
Knee	2		18		9	3	3	3	38
Tibia			2			1			3
Fibula					2		1		3
Tibia and fibula	1		3					1	5
Lower leg	8		25	4	4	4	7	2	54
Ankle	8		28		6	6	5	29	82
Foot	7		71	8	6	32	54	24	202
Both feet				1			1	1	3
Great toe	3		40	1	1	18	34	1	98
Great toe and others	1		4			3	1		9
Other toes	2		1			2	2		7
Unclassified	1		3	1				7	12
Total	101		487	51	73	104	300	185	1,301

TABLE 3.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY CAUSE AND LOCATION OF INJURY**—Concluded.

UNCLASSIFIED.

Location of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Head:									
Eye	86	1	1	78	2	3	85	250	506
Skull	6	1	2	......	7	4	1	2	23
Other parts of head	37	1	17	35	32	35	27	37	221
Face and neck	64	3	7	104	24	9	63	25	299
Trunk:									
Back	24	......	17	21	50	14	223	11	360
Vertibrae	......	......	......	......	1	......	......	......	1
Thorax	44	......	23	15	59	9	65	17	232
Abdomen	18	......	4	6	5	6	18	7	64
Groin	2	......	......	1	3	2	56	5	69
Pelvis	2	......	2	......	1	......	2	......	7
Generative organs	2	......	......	......	4	2	6	1	15
Upper extremities:									
Scapula	......	......	......	......	......	1	1	1	3
Clavicle	1	......	1	......	......	1	1	1	5
Shoulder	18	......	9	3	29	10	40	10	119
Upper arm	9	......	......	5	2	3	8	3	30
Elbow	10	......	3	2	11	......	16	12	54
Ulna	2	......	2	......	2	......	2	......	8
Radius	1	......	3	......	8	......	1	1	14
Ulna and radius	2	......	......	......	2	......	......	1	5
Forearm	39	1	......	60	25	10	47	21	203
Wrist	33	......	11	13	29	3	74	12	175
Hand	123	1	6	72	30	41	275	54	602
Both hands	......	......	......	17	1	1	2	......	21
1 finger	223	......	8	17	11	56	547	37	899
2 fingers	42	......	4	8	......	9	44	5	112
3 fingers	8	......	......	......	......	1	5	1	15
4 fingers	4	......	......	......	......	......	3	......	7
Thumb	84	1	3	7	9	12	139	12	267
Thumb and 1 finger	1	......	......	1	......	......	......	......	2
Thumb and 2 fingers	1	......	......	1	......	......	1	......	3
Thumb and 3 fingers	......	......	......	1	......	......	......	......	1
Lower extremities:									
Hip	5	......	4	1	16	4	10	4	44
Femur	4	......	2	......	4	14	1	1	26
Upper leg	35	......	15	25	17	......	40	20	152
Knee	14	......	8	7	54	18	40	35	176
Tibia	2	......	1	......	5	3	1	2	14
Fibula	1	......	......	......	......	3	2	1	7
Tibia and fibula	10	......	1	......	2	5	4	3	25
Lower leg	48	......	15	38	31	49	55	41	277
Ankle	28	......	9	15	47	34	51	128	312
Foot	118	......	22	68	27	301	437	161	1,134
Both feet	2	......	1	7	1	2	2	1	16
Great toe	45	......	11	4	1	188	245	12	506
Great toe and others	5	......	......	1	......	9	7	1	23
Other toes	3	......	......	......	......	7	5	1	16
Unclassified	5	3	1	11	1	......	......	81	102
Total	1,211	12	213	644	553	869	2,652	1,018	7,172

TABLE 4.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY CAUSE AND NATURE OF INJURY.**

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
BLAST FURNACES.									
Abrasion	3		5		5	5	16	162	196
Bruise	39		67	1	78	94	213	36	528
Cut								1	1
Laceration	40		26	2	33	36	144	32	313
Puncture	6		1	1	5	4	27	20	64
Burn or scald	1	2		414	1		2	6	426
Concussion					1			1	2
Dislocation	2				4	1	2		9
Fracture	38	1	25	3	34	41	56	12	210
Sprain or strain (not hernia)	6		12		33	2	93	44	190
Accidental dismemberment	8		1	1		1	2		13
Nervous shock								2	2
Abrasion with infection	1		1	1	1	1	4	15	24
Cut with infection							1		1
Laceration with infection						3	7		10
Puncture with infection							3		3
Burn or scald with infection				4					4
Fracture with infection							1	1	2
Hernia	1				2		6		5
Asphyxia					2		1	72	70
Electric flash	1		1	8					19
Crushing injury	6		10			2	4		22
Electric shock				1					1
Loss of teeth							1		1
Unclassified	1						1	10	12
Total	153	3	149	436	199	190	584	414	2,128
BESSEMER.									
Abrasion	1		1	1	1		2	43	49
Bruise	19		17		19	24	48	10	137
Laceration	14		11		3	22	28	15	93
Puncture	1						8	1	10
Burn or scald				117		1	1	1	120
Dislocation					2			1	3
Fracture	13		7	1	14	13	24	2	74
Sprain or strain (not hernia)			1		8	1	10	11	31
Accidental dismemberment	1		1			1	2		5
Abrasion with infection						1	3	4	8
Laceration with infection							4	1	5
Burn or scald with infection				1					1
Hernia							1		1
Crushing injury	5		11			5	1	1	23
Heat exhaustion								1	1
Unclassified						1			1
Total	54		49	120	47	69	132	91	562
OPEN HEARTH.									
Abrasion	8		3	2	8	7	22	126	176
Bruise	140		85		91	168	305	63	852
Cut	1						1		2
Laceration	130		41	1	75	115	268	59	689
Puncture	3		1		1	2	19	40	66
Burn or scald	2			747	3		3	10	765
Concussion	2		1					1	4
Dislocation	1		1		4		1		7
Fracture	78		32	3	47	51	80	7	298
Sprain or strain (not hernia)	6		11		51	10	137	84	299
Accidental dismemberment	9		6			1	5		21
Nervous shock				1	1			1	3
Abrasion with infection	2			1	1	1	16	16	37
Laceration with infection	1			1			7	1	10
Puncture with infection							3		3
Burn or scald with infection				6					6
Hernia							8	1	9
Asphyxia								25	25
Electric flash				17		1			18
Crushing injury	20		21			5	6	1	53
Heat exhaustion								17	17
Electric shock				1					1
Unclassified				1					1
Total	403		202	781	282	361	881	452	3,362

TABLE 4.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Continued.

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total
FOUNDRIES.									
Abrasion	21		1	3	4	9	37	121	196
Bruise	120		11		28	141	186	32	518
Laceration	112		3		15	43	172	29	374
Puncture	1				1		20	42	64
Burn or scald	2			160				1	163
Dislocation	1						1		2
Fracture	48		5		8	38	42	6	147
Sprain or strain (not hernia)	3		1		20	3	68	23	118
Accidental dismemberment	4								4
Abrasion with infection						1	7	6	14
Laceration with infection							2	2	4
Puncture with infection							2		2
Burn or scald with infection				1		1			2
Hernia					1		11	1	13
Asphyxia								1	1
Electric flash				6					6
Crushing injury	12					3	4		19
Heat exhaustion								2	2
Total	324		21	170	77	239	552	266	1,649
HEAVY ROLLING MILLS.									
Abrasion	14			8	1	6	13	99	141
Bruise	138		13		80	155	283	55	724
Laceration	143		13		42	67	219	55	539
Puncture	5			2			13	13	33
Burn or scald	9	1		210	6		1	5	232
Concussion	1					1	1		3
Dislocation	3				1		3		7
Fracture	92		17	1	35	72	96	13	326
Sprain or strain (not hernia)	9		7		36	7	118	63	240
Accidental dismemberment	11					2	4		17
Nervous shock	1				1				2
Abrasion with infection						1	10	11	22
Laceration with infection	3						2	2	7
Puncture with infection							1	1	2
Burn or scald with infection				4					4
Fracture with infection					1		1		2
Hernia			1		1		5		7
Asphyxia								1	1
Electric flash				20					20
Crushing injury	21		10			5	9	1	46
Heat exhaustion								10	10
Loss of teeth	1								1
Unclassified	1						1	2	4
Total	452	1	61	245	204	316	780	331	2,390
PLATE MILLS.									
Abrasion	5				3	7	10	43	68
Bruise	130		12		42	158	192	64	598
Cut							1	1	2
Laceration	144		6		30	80	199	73	532
Puncture	3					10	42	46	101
Burn or scald	4			141	1	1	4		151
Concussion					1	1			2
Dislocation	1				2		4		7
Fracture	59		2	1	12	37	45	8	164
Sprain or strain (not hernia)	4				29	2	96	29	160
Accidental dismemberment	8					2	5		15
Nervous shock	1								1
Abrasion with infection	1						6	5	12
Cut with infection	1								1
Laceration with infection							3	1	4
Puncture with infection							3		3
Burn or scald with infection				1					1
Hernia							6	1	7
Asphyxia				1					1
Electric flash				18					18
Crushing injury	10					4	4		18
Heat exhaustion								17	17
Loss of teeth	1						1		2
Total	372		20	162	120	302	612	288	1,885

TABLE 4.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENT IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Continued.

TUBE MILLS.

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	4				1	1	7	41	54
Bruise	25		3		13	29	62	20	152
Cut							3		3
Laceration	39		2		9	13	66	26	155
Puncture	2						7	8	17
Burn or scald	2			52					54
Concussion	1								1
Dislocation						1	1		2
Fracture	23		1		9	14	37	3	87
Sprain or strain (not hernia)	4				6	3	22	1	36
Accidental dismemberment	5						2		7
Abrasion with infection			1				2	2	5
Laceration with infection							2	5	7
Puncture with infection							1		1
Burn or scald with infection				1					1
Hernia							6		6
Electric flash				1					1
Crushing injury	14		2			3	3	2	24
Heat exhaustion								6	6
Unclassified								3	3
Total	119		9	54	38	64	221	117	622

FABRICATING.

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	13				1		12	176	202
Bruise	107		5		25	76	78	20	311
Cut							1		1
Laceration	229		6		28	61	173	34	531
Puncture	10					1	11	25	47
Burn or scald	3			37			1	3	44
Dislocation	3				2		1	2	8
Fracture	112		1		13	51	83	8	268
Sprain or strain (not hernia)	17		1		24		31	26	99
Accidental dismemberment	9						1		10
Abrasion with infection	1			1		1	5	1	9
Cut with infection							1		1
Laceration with infection	2						2	2	6
Burn or scald with infection				2					2
Hernia					1		3		4
Asphyxia								1	1
Electric flash				1					1
Crushing injury	23					7	5	1	36
Loss of teeth							1		1
Unclassified								2	2
Total	529		13	41	94	197	409	301	1,584

ELECTRICAL.

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	8				1		3	30	42
Bruise	16		4		22	10	20	10	82
Laceration	26		1		9	10	28	9	83
Puncture					1		1	11	13
Burn or scald	1			81					82
Dislocation	1					1			2
Fracture	13		1		15	9	7	1	46
Sprain or strain (not hernia)			1		22	2	14	19	58
Accidental dismemberment							3		3
Abrasion with infection	1						3	3	7
Laceration with infection					1		1		2
Puncture with infection							3		3
Hernia					1		2		3
Asphyxia				1				2	3
Electric flash				38					38
Crushing injury	10						3		13
Heat exhaustion								4	4
Electric shock				4					4
Loss of teeth					1				1
Total	76		7	124	73	32	88	89	489

TABLE 4.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Continued.

MECHANICAL.

Nature of injury:	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	87				6	3	48	191	335
Bruise	134		26	2	104	216	342	79	903
Cut							1		1
Laceration	221		7	1	55	84	302	57	727
Puncture	9					1	49	68	127
Burn or scald	26			168			4	6	204
Concussion						2			2
Dislocation	2				9		2	4	17
Fracture	94		13	1	48	63	111	9	339
Sprain or strain (not hernia)	12	1	3		68	9	138	72	303
Accidental dismemberment	17					1	11		29
Nervous shock					1		1	3	5
Abrasion with infection	10			1	1	1	19	30	62
Laceration with infection	2						15	2	19
Puncture with infection							6		6
Burn or scald with infection				2					2
Hernia					1		24	1	26
Asphyxia								19	19
Electric flash				7					7
Crushing injury	23		3	1		4	16	1	48
Heat exhaustion								6	6
Electric shock				1					1
Loss of teeth	1								1
Frosted								1	1
Other					1				1
Total	638	1	52	184	294	384	1,089	549	3,191

YARDS.

Nature of injury:	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	2		10		3	1	5	67	88
Bruise	36		182		31	56	95	30	430
Laceration	30		103	1	14	18	70	19	255
Puncture			2			2	10	12	26
Burn or scald	2		2	45					49
Concussion				1					1
Dislocation			4		1	1			6
Fracture	18		81		11	24	45	7	186
Sprain or strain (not hernia)	2		55		13		53	29	152
Accidental dismemberment	3		7				2		12
Nervous shock			1						1
Abrasion with infection	1			1			6	13	21
Laceration with infection							1	1	2
Puncture with infection							2		2
Fracture with infection			1						1
Hernia			2				7		9
Asphyxia								2	2
Electric flash				2					2
Crushing injury	7		37			2	4		50
Heat exhaustion								4	4
Electric shock				1					1
Other								1	1
Total	101		487	51	73	104	300	185	1,301

TABLE 4.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND NATURE OF INJURY—Concluded.

SHEET ROLLING MILLS.

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	2							11	13
Bruise	28				13	23	68	6	138
Laceration	21		1		8	8	227	93	358
Puncture							5	3	8
Burn or scald				39	2		1		42
Concussion					1				1
Dislocation					1				1
Fracture	9				2	8	12	5	34
Sprain or strain (not hernia)	4				13		46	11	76
Accidental dismemberment	8					1	4	1	14
Abrasion with infection							15		15
Laceration with infection							4		4
Hernia							6		6
Crushing injury	1						4		5
Total	73		1	39	40	40	392	130	715

UNCLASSIFIED.

Nature of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Abrasion	51		4	1	9	9	53	207	334
Bruise	396		89		201	500	917	180	2,283
Cut							1	1	2
Laceration	398	2	41	2	112	187	806	193	1,741
Puncture	15		1	1	1	5	76	103	202
Burn or scald	35	8		595	11	1	11	12	673
Concussion	1				3	2			6
Dislocation	5	1	4		5		9	3	27
Fracture	167	1	35	1	79	132	206	27	648
Sprain or strain (not hernia)	39		18		124	12	396	162	751
Accidental dismemberment	43		2	1	1	3	19		69
Nervous shock				1		1			2
Abrasion with infection	6			3	3	2	42	24	80
Cut with infection							2		2
Laceration with infection	3		1				28	11	43
Puncture with infection					1		10	1	12
Burn or scald with infection	1			15			1	2	19
Hernia	1				2	1	43	2	49
Asphyxia								22	22
Electric flash				22				1	23
Crushing injury	48		16	1	1	14	30	4	114
Heat exhaustion								38	38
Frosted								2	2
Other	2		2	1			2	23	30
Total	1,211	12	213	644	553	869	2,652	1,018	7,172

TABLE 5.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND RESULT OF INJURY.

BLAST FURNACES.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	9	2	15	13	4	4	1	11	59
Permanent disability: Loss of—									
Both eyes				1					1
1 hand	1						1		2
1 leg	2		1						3
1 foot			1						1
1 eye				3	2		2	3	10
1 thumb	2								2
1 finger	8						3		11
2 fingers	1		1			1			3
3 fingers	2								2
4 fingers	1								1
Thumb and 1 finger				1					1
Thumb and 3 fingers					1				1
Great toe	1						1		2
Any 2 toes	1								1
All other					1				1
Total	19		3	5	4	1	7	3	42
Temporary disability, terminating in—									
1st week	47	1	60	144	85	76	305	302	1,020
2d week	21		23	91	35	41	114	54	379
3d week	19		7	67	17	20	71	19	220
4th week	7		13	35	14	11	30	10	120
5th week	9		6	33	13	14	21	8	104
6th-13th week	13		18	36	23	14	26	6	136
14th week and later	9		4	12	3	9	9	1	47
All other					1				1
Total	125	1	131	418	191	185	576	400	2,027
Grand total	153	3	149	436	199	190	584	414	2,128

BESSEMER.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	4		3	6		2			15
Permanent disability: Loss of—									
1 eye								1	1
1 thumb			2						2
1 finger	3		3				2		8
3 fingers	1								1
Great toe						2	1		3
All other							1		1
Total	4		5			2	4	1	16
Temporary disability, terminating in—									
1st week	14		13	40	12	26	50	60	215
2d week	8		6	13	4	8	25	12	76
3d week	2		5	13	4	10	16	6	56
4th week	7			13	5	7	14	1	47
5th week	3		3	6	4	4	5	3	28
6th-13th week	9		9	23	12	4	13	6	76
14th week and later	3		5	6	6	5	5	2	32
All other						1			1
Total	46		41	114	47	65	128	90	531
Grand total	54		49	120	47	69	132	91	562

TABLE 5.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND RESULT OF INJURY—Continued.

OPEN HEARTHS.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	16		8	14		7	1	1	47
Permanent disability: Loss of—									
Both legs			1						1
1 arm			1						1
1 hand				1					1
1 foot	2		2						4
1 eye	1			1		1	1	2	6
1 thumb	4		2				3		9
1 finger	10		8				8		26
2 fingers			1	1			1		3
3 fingers	1								1
4 fingers	1								1
Thumb and 2 fingers	1								1
Thumb and 4 fingers			1						1
Great toe						2			2
Any 2 toes	2								2
Total	22		16	3		3	13	2	59
Temporary disability, terminating in—									
1st week	134		58	310	124	152	460	332	1,570
2d week	69		30	129	49	73	153	67	570
3d week	44		17	128	30	36	98	23	376
4th week	26		21	52	17	32	53	9	210
5th week	25		21	48	10	23	37	8	172
6th-13th week	46		23	77	38	29	65	7	285
14th week and later	21		8	20	14	6		3	72
All other							1		1
Total	365		178	764	282	351	867	449	3,256
Grand total	403		202	781	282	361	881	452	3,362

FOUNDRIES.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	4			3	1	2			10
Permanent disability: Loss of—									
1 hand	1								1
1 leg							1		1
1 eye								1	1
1 thumb	3				1		1		5
1 finger	6						3	2	11
2 fingers	1								1
3 fingers							1		1
Thumb and 4 fingers	1								1
Great toe						1			1
Any 2 toes						1			1
Total	12				1	2	6	3	24
Temporary disability, terminating in—									
1st week	116		7	58	39	86	282	182	771
2d week	55		4	34	14	52	132	54	345
3d week	35		4	20	7	30	53	8	157
4th week	38		2	14	4	20	26	4	108
5th week	21		2	10	2	11	18	4	68
6th-13th week	38		2	26	8	29	32	8	143
14th week and later	5			5		7	3	3	23
Total	308		21	167	75	235	546	263	1,615
Grand total	324		21	170	77	239	552	266	1,649

TABLE 5.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND RESULT OF INJURY—Continued.

HEAVY ROLLING MILLS.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	7		6	6				3	22
Permanent disability: Loss of—									
1 arm	1		1						2
1 hand	3		1						4
1 leg	2		1						3
1 foot	1				1	2			4
1 eye				3			4	1	8
1 thumb	3					2	1		6
1 finger	16		1			1	11		29
2 fingers	6						2		8
3 fingers	2		1						3
Thumb and 2 fingers	1								1
Great toe	7		1			2	1		11
Any two toes			1			2			3
Total	42		7	3	1	9	19	1	82
Temporary disability, terminating in—									
1st week	140		14	110	100	140	410	217	1,131
2d week	65	1	7	42	30	51	140	39	375
3d week	47		3	23	19	26	72	17	207
4th week	37		6	16	8	22	39	13	141
5th week	39		4	12	2	22	31	8	118
6th-13th week	59		10	22	36	34	56	27	244
14th week and later	16		4	11	8	12	13	6	70
Total	403	1	48	236	203	307	761	327	2,286
Grand total	452	1	61	245	204	316	780	331	2,390

PLATE MILLS.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	6			2				2	10
Permanent disability: Loss of—									
1 foot	2					1			3
1 thumb	3					1	3		7
1 finger	9						4		13
Thumb and 3 fingers	1								1
Great toe	2						1		3
Any two toes	2					1			3
Total	19					3	8		30
Temporary disability, terminating in—									
1st week	124		11	89	64	150	360	191	989
2d week	64		1	33	20	59	115	41	333
3d week	43		5	13	8	33	44	24	170
4th week	29			10	10	16	26	8	99
5th week	19		1	7	5	12	19	9	72
6th-13th week	53		1	7	11	21	45	9	147
14th week and later	15		1	1	2	8	4	4	35
Total	347		20	160	120	299	613	286	1,845
Grand total	372		20	162	120	302	621	288	1,885

TABLE 5.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND RESULT OF INJURY—Continued.

TUBE MILLS.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	4			1	1		1	2	9
Permanent disability: Loss of—									
Both eyes	1								1
1 eye	1						1		2
1 thumb	1		1				2	1	5
1 finger	10						3	1	14
2 fingers	3					1			4
Thumb and 2 fingers			1						1
Any 2 toes	2								2
Total	18		2			1	6	2	29
Temporary disability, terminating in—									
1st week	26			21	9	18	76	59	209
2d week	17		2	13	11	17	53	24	137
3d week	10			8	5	11	26	10	70
4th week	10		2	3	1	5	24	6	51
5th week	8		1	2	3	5	9	3	31
6th-13th week	18			4	5	4	23	6	60
14th week and later	8		2	2	3	3	3	5	26
Total	97		7	53	37	63	214	113	584
Grand total	119		9	54	38	64	221	117	622

FABRICATING.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	5			1	1	1		1	9
Permanent disability: Loss of—									
1 leg	1								1
1 eye	2								2
1 thumb	5								5
1 finger	26					2	4	2	34
2 fingers	3								3
3 fingers	1								1
Great toe	2								2
Any 2 toes						2			2
Total	40					4	4	2	50
Temporary disability, terminating in—									
1st week	161		4	15	44	68	173	232	697
2d week	142		3	12	19	58	111	46	391
3d week	79		1	7	7	28	48	10	180
4th week	26			3	7	13	30	5	84
5th week	23			2	4	6	21	4	60
6th-13th week	41		3	1	9	16	20	1	91
14th week and later	12		1		2	3	2		20
Other			1		1				2
Total	484		13	40	93	192	405	298	1,525
Grand total	529		13	41	94	197	409	301	1,584

ELECTRICAL.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	5			4	2			1	12
Permanent disability: Loss of—									
Both eyes				1					1
1 arm	1								1
1 finger	1						3		4
2 fingers	2						1		3
Thumb and 3 fingers	1								1
Great toe	1								1
Total	6			1			4		11

TABLE 5.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY CAUSE AND RESULT OF INJURY**—Continued.

ELECTRICAL—Concluded.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Temporary disability, terminating in—									
1st week	27		2	65	31	9	38	71	243
2d week	9			21	11	8	20	8	77
3d week	4		1	17	3	4	11	4	44
4th week	9		1	7	1	1	2	1	22
5th week	5		1	3	5	3	4		21
6th–13th week	9		2	5	15	7	8	4	50
14th week and later	2			1	5		1		9
Total	65		7	119	71	32	84	88	466
Grand total	76		7	124	73	32	88	89	489
YARDS.									
Death	5		20			1		4	30
Permanent disability: Loss of—									
1 arm			2						2
1 leg	1							1	2
1 foot			6						6
1 eye	1						2	3	6
1 thumb	1		3						4
1 finger	5		11				3		19
2 fingers			1				1		2
Great toe						1			1
Any two toes	1		1						2
Total	9		24			1	6	4	44
Temporary disability, terminating in—									
1st week	37		183	24	32	45	148	118	587
2d week	14		75	6	14	15	49	27	200
3d week	13		44	5	12	5	28	8	115
4th week	6		31	5	5	7	18	6	78
5th week	6		22	3	3	10	17	4	65
6th–13th week	7		68	8	6	16	30	11	146
14th week and later	4		20		1	4	4	3	36
Total	87		443	51	73	102	294	177	1,227
Grand total	101		487	51	73	104	300	185	1,301
MECHANICAL.									
Death	8		2	3	5	2	1	2	23
Permanent disability: Loss of—									
1 hand	1						1		2
1 leg			1					1	2
1 foot			1				1		2
1 eye	2						5	6	13
1 thumb	7						4		11
1 finger	13					2	13		28
2 fingers	4								4
3 fingers	1								1
Thumb and 1 finger	2								2
Thumb and 2 fingers	1								1
Great toe	2						1		3
Total	33		2			2	25	7	69
Temporary disability, terminating in—									
1st week	278		14	78	135	182	537	394	1,618
2d week	94	1	9	41	53	62	215	69	544
3d week	59		5	24	25	40	107	34	294
4th week	47		4	13	16	37	72	13	202
5th week	41			12	7	17	45	8	130
6th–13th week	60		9	11	38	36	83	19	256
14th week and later	18		7	2	15	6	4	3	55
Total	597	1	48	181	289	380	1,063	540	3,099
Grand total	638	1	52	184	294	384	1,089	549	3,191

TABLE 5.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY CAUSE AND RESULT OF INJURY—Concluded.

SHEET ROLLING MILLS.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death									
Permanent disability: Loss of—									
1 eye							1		1
1 thumb							1		1
1 finger	5					1	4	1	11
2 fingers	2								2
4 fingers	1								1
Total	8					1	6	1	16
Temporary disability, terminating in—									
1st week	23			13	15	9	125	57	242
2d week	15			12	11	11	117	26	192
3d week	5		1	9	3	8	56	18	100
4th week	4			3	5	3	32	8	55
5th week	5			2		1	30	4	32
6th-13th week	10				6	3	32	16	67
14th week and later	3					4	4		11
Total	65		1	39	40	39	386	129	699
Grand total	73		1	39	40	40	392	130	715

UNCLASSIFIED.

Result of injury.	Machinery.	Steam apparatus.	Power vehicles.	Hot substances.	Falls of worker.	Falling objects.	Handling objects and tools.	Unclassified.	Total.
Death	18	4	14	8	7	7		10	68
Permanent disability: Loss of—									
1 arm	3		1						4
1 hand	2						1		3
1 leg	1		3			2	1		7
1 foot	2		1	2					5
1 eye	2			2			5	9	18
1 thumb	15				1	1	5		22
1 finger	31		1		1	1	25	1	60
2 fingers	6		1				1		8
3 fingers	1							1	2
4 fingers	3								3
Great toe						1	1		2
Any two toes	2					3	1		6
All other					1				1
Total	68		7	4	3	8	40	11	141
Temporary disability, terminating in—									
1st week	426	3	70	266	242	379	1,292	609	3,285
2d week	233	2	40	133	116	143	536	174	1,377
3d week	128	2	24	112	60	109	305	84	824
4th week	85		22	42	37	67	137	46	436
5th week	76		11	22	26	48	141	27	351
6th-13th week	141	1	20	45	49	96	183	43	578
14th week and later	36		5	12	13	14	18	14	112
Total	1,125	8	192	632	543	854	2,612	997	6,963
Grand total	1,211	12	213	644	553	869	2,652	1,018	7,172

TABLE 6.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION OF INJURY.

Location of injury.	Blast furnaces	Bessemer.	Open-hearths.	Foundries.	Heavy rolling mills.	Plate mills.	Tube mills.	Sheet mills.	Fabrication.	Electrical.	Mechanical.	Yards.	Unclassified.	Total.
Head:														
Eye	284	75	280	238	203	89	80	25	278	60	447	108	506	2,673
Skull	26	2	11	4	15	5	3	...	5	5	12	4	23	115
Other parts of head	94	28	152	37	104	60	17	8	43	45	118	50	221	977
Face and neck	131	22	255	49	116	67	24	15	81	29	128	42	299	1,258
Trunk:														
Back	117	23	206	59	110	87	29	18	33	15	132	70	360	1,259
Vertebræ	1	...	2	...	...	2	...	...	...	...	...	...	1	6
Thorax, external	83	32	135	46	69	51	27	13	36	10	72	57	229	860
Thorax, internal	1	2	3	...	...	...	...	...	...	2	2	3	3	16
Abdomen, external	19	8	20	10	24	18	8	...	4	3	18	6	59	197
Abdomen, internal	1	1	4	...	3	1	...	...	...	...	2	1	5	18
Groin	16	2	9	13	12	9	9	8	4	6	35	8	69	200
Pelvis	3	...	5	2	4	2	1	...	...	2	4	3	7	33
Generative organs	7	...	6	...	6	2	6	...	...	...	6	4	15	52
Upper extremities:														
Scapula	...	...	...	1	2	...	...	...	...	...	2	...	3	8
Clavicle	4	1	7	...	3	3	1	...	2	1	5	2	5	34
Shoulder	31	11	50	10	31	19	8	5	7	6	63	24	112	377
Humerus	...	...	5	1	1	1	...	...	3	...	4	4	7	26
Upper arm	6	1	10	8	7	5	...	7	14	1	13	6	30	108
Elbow	21	2	19	15	15	9	6	9	14	8	44	4	54	220
Ulna	2	...	2	...	4	4	1	...	2	2	3	2	8	30
Radius	1	1	10	2	6	1	3	...	2	2	9	5	14	56
Ulna and radius	2	2	...	...	2	1	...	...	2	...	5	2	5	21
Forearm	43	9	84	28	45	67	17	72	18	5	59	14	203	664
Wrist	38	8	55	31	36	49	9	38	15	16	70	19	175	559
Hand	117	25	229	104	176	150	56	65	78	57	245	71	602	1,975
Both hands	21	5	22	5	15	5	3	6	...	5	9	2	21	119
1 finger	194	57	359	267	254	190	81	89	324	40	395	150	899	3,299
2 fingers	20	7	40	33	30	26	13	10	39	5	48	22	112	405
3 fingers	2	1	8	2	8	7	1	3	4	1	4	2	15	58
4 fingers	1	...	...	...	1	1	...	1	1	...	4	...	7	16
Thumb	49	16	97	76	67	56	22	21	59	14	126	41	267	911
Thumb and 1 finger	1	...	1	...	...	...	1	...	...	1	5	1	2	12
Thumb and 2 fingers	...	...	2	1	1	...	...	...	...	...	2	...	3	9
Thumb and 3 fingers	...	...	...	...	1	...	...	...	...	...	...	...	1	2
Thumb and 4 fingers	1	...	...	...	...	...	...	...	...	...	...	...	...	1
Lower extremities:														
Hip	8	2	21	4	12	11	6	4	6	2	13	7	44	140
Femur	7	3	9	2	5	5	2	...	5	1	4	6	26	75
Upper leg	48	14	71	39	71	113	16	10	34	11	85	45	152	709

Knee	59	10	73	33	61	43	11	34	53	12	93	38	176	696
Tibia	4	2	2	2	2	1	1	1	2	....	4	3	14	38
Fibula	1	2	4	1	7	6	1	2	5	1	7	3	7	47
Tibia and fibula	5	4	9	4	11	4	1	3	....	5	13	5	25	89
Lower leg	63	28	122	46	110	65	17	22	43	12	71	54	277	930
Ankle	101	25	203	74	140	84	14	62	55	37	133	82	312	1,322
Foot	266	77	464	240	348	321	81	135	159	44	428	202	1,134	3,809
Both feet	11	....	12	7	6	7	3	1	....	....	4	3	16	70
Great toe	110	39	204	135	186	207	29	27	135	11	193	98	506	1,880
Great toe and others	8	2	10	15	13	5	1	....	15	1	12	9	23	114
Other toes	3	7	10	....	27	8	3	....	....	....	9	7	16	90
Unclassified	97	6	60	5	20	18	10	1	4	11	31	12	102	377
Total	2,128	562	3,362	1,649	2,390	1,885	622	715	1,584	489	3,191	1,301	7,172	27,050

TABLE 7.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY.

BLAST FURNACES.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	173	1	1	8	11	1	1	196
Bruise	32	92	40	76	79	208	1	528
Cut	1							1
Laceration	125	2	6	137	17	26		313
Puncture	8		4	27	5	20		64
Burn or scald	137	32	30	82	39	96	10	426
Concussion	2							2
Dislocation			3	3	2	1		9
Fracture	24	16	12	57	21	80		210
Sprain or strain (not hernia)		83	11	21	14	61		190
Accidental dismemberment	1			12				13
Nervous shock							2	2
Abrasion with infection	17		2	3	2			24
Cut with infection				1				1
Laceration with infection	1			6	4			11
Puncture with infection				3				3
Burn or scald with infection			1	1		2		4
Fracture with infection		1						1
Hernia		9						9
Asphyxia							75	75
Electric flash	10							10
Crushing injury	1	10		6	1	3	1	22
Electric shock							1	1
Loss of teeth	1							1
Unclassified	4					1	7	12
Total	537	246	110	443	195	499	98	2,128

OPEN HEARTHS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and fingers.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	138	2	3	15	10	8		176
Bruise	37	131	49	141	144	350		852
Cut		1		1				2
Laceration	171	3	23	340	48	104		689
Puncture	2		3	17	4	40		66
Burn or scald with infection	289	89	60	105	44	163	15	765
Concussion	4							4
Dislocation			5	1	1			7
Fracture	18	23	29	96	26	106		298
Sprain or strain (not hernia)	2	119	14	21	24	119		299
Accidental dismemberment				19		2		21
Nervous shock	1						2	3
Abrasion with infection	14		1	17	4	1		37
Laceration with infection	1			7	1	1		10
Puncture with infection				3				3
Burn or scald with infection				4	2			6
Hernia		9						9
Asphyxia							25	25
Electric flash	18							18
Crushing injury	2	13		26	3	9		53
Heat exhaustion							17	17
Electric shock							1	1
Unclassified	1							1
Total	698	390	187	813	311	903	60	3,362

TABLE 7.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY LOCATION AND NATURE OF INJURY**—Continued.

FOUNDRIES.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	168	1	2	9	9	7		196
Bruise	14	44	26	137	73	223	1	518
Laceration	75		6	222	22	49		374
Puncture	3	1	5	20	3	32		64
Burn or scald	52	9	9	25	2	65	1	163
Dislocation			1			1		2
Fracture	5	7	4	57	14	60		147
Sprain or strain (not hernia)		52	12	19	7	28		118
Accidental dismemberment				4				4
Abrasion with infection	5			8		1		14
Laceration with infection				4				4
Puncture with infection				2				2
Burn or scald with infection						2		2
Hernia		13						13
Asphyxia							1	1
Electric flash	6							6
Crushing injury		3		12	1	3		19
Heat exhaustion							2	2
Total	328	130	65	519	131	471	5	1,649

HEAVY ROLLING MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	121	1	3	5	9	2		141
Bruise	40	88	32	104	137	322	1	724
Laceration	142	5	12	235	52	93		539
Puncture	8		3	9	4	9		33
Burn or scald	66	22	23	59	19	39	4	232
Concussion	3							3
Dislocation			2	3	1	1		7
Fracture	17	12	23	98	30	145	1	326
Sprain or strain (not hernia)	1	87	18	21	20	93		240
Accidental dismemberment				13		4		17
Nervous shock							2	2
Abrasion with infection	12			9	1			22
Laceration with infection	1			3	2	1		7
Puncture with infection		1		1				2
Burn or scald with infection	2			1		1		4
Fracture with infection				1	1			2
Hernia		7						7
Asphyxia							1	1
Electric flash	20							20
Crushing injury	3	5		25	3	9	1	46
Heat exhaustion							10	10
Loss of teeth	1							1
Unclassified	1			2			1	4
Total	438	228	116	589	279	719	21	2,390

PLATE MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	44		1	5	11	7		68
Bruise	14	69	21	69	113	311	1	598
Cut	1				1			2
Laceration	65	4	40	238	61	124		532
Puncture	1	1	6	29	23	41		101
Burn or scald	55	5	15	43	10	23		151
Concussion	2							2
Dislocation			4	3				7
Fracture	9	11	11	47	18	68		164
Sprain or strain (not hernia)	1	75	12	17	9	46		160
Accidental dismemberment				12		3		15
Nervous shock							1	1
Abrasion with infection	7			4	1			12
Cut with infection	1							1
Laceration with infection				3	1			4
Puncture with infection				3				3
Burn or scald with infection						1		1
Hernia		7						7
Asphyxia							1	1
Electric flash	18							18
Crushing injury				10		8		18
Heat exhaustion							17	17
Loss of teeth	2							2
Total	220	172	110	483	248	632	20	1,885

TABLE 7.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY—Continued.

TUBE MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	44	1	1	5	2	1		54
Bruise	9	34	9	16	20	63	1	152
Cut				3				3
Laceration	32	4	8	84	14	13		155
Puncture	6			4	2	5		17
Burn or scald	25	2	3	12	5	7		54
Concussion	1							1
Dislocation				1		1		2
Fracture	2	11	7	29	6	31	1	87
Sprain or strain (not hernia)		19	6	2	5	4		36
Accidental dismemberment	1			6				7
Abrasion with infection	2		1	2				5
Laceration with infection		1		5	1			7
Puncture with infection				1				1
Burn or scald with infection				1				1
Hernia		6						6
Electric flash	1							1
Crushing injury	1	2		15		6		24
Heat exhaustion							6	6
Unclassified			1				2	3
Total	124	80	36	186	55	131	10	622

FABRICATION.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	196			3	3			202
Bruise	18	29	21	48	76	119		311
Cut				1				1
Laceration	144	1	20	262	25	79		531
Puncture	8	3	2	10	4	20		47
Burn or scald	29		2	5	3	4	1	44
Dislocation				6	1	1		8
Fracture	9	13	12	121	15	98		268
Sprain or strain (not hernia)		24	7	14	16	37	1	99
Accidental dismemberment				10				10
Abrasion with infection	1			5	3			9
Cut with infection				1				1
Laceration with infection				4	2			6
Burn or scald with infection				2				2
Hernia		4						4
Asphyxia							1	1
Electric flash	1							1
Crushing injury		3		27		6		36
Loss of teeth	1							1
Unclassified				1			1	2
Total	407	77	64	520	148	364	4	1,584

ELECTRICAL.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	37			1	4			42
Bruise	7	14	5	15	19	22		82
Laceration	22			46	6	9		83
Puncture			1		2	10		13
Burn or scald	22	3	4	42	4	6	1	82
Dislocation			1	1				2
Fracture	8	2	5	10	7	14		46
Sprain or strain (not hernia)		14	6	5	2	31		58
Accidental dismemberment				3				3
Abrasion with infection	3			4				7
Laceration with infection			1	1				2
Puncture with infection			1	2				3
Hernia		3						3
Asphyxia							3	3
Electric flash	38							38
Crushing injury		2	1	9		1		13
Heat exhaustion							4	4
Electric shock	1						3	4
Loss of teeth	1							1
Total	139	38	25	139	44	93	11	489

TABLE 7.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND NATURE OF INJURY—Continued.

MECHANICAL.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	298		9	11	10	7		335
Bruise	48	88	76	178	141	372		903
Cut				1				1
Laceration	183	8	31	396	42	67		727
Puncture	19	2	8	24	10	64		127
Burn or scald	90	6	15	61	11	21		204
Concussion	2							2
Dislocation	1		9	4	1	2		17
Fracture	14	15	32	104	30	144		339
Sprain or strain (not hernia)	3	118	24	31	34	93		303
Accidental dismemberment				28		1		29
Nervous shock							5	5
Abrasion with infection	37		2	17	5	1		62
Laceration with infection	1			17	1			19
Puncture with infection				5		1		6
Burn or scald with infection				1	1			2
Hernia		26						26
Asphyxia							19	19
Electric flash	7							7
Crushing injury	1	7	1	29	4	6		48
Heat exhaustion							6	6
Electric shock							1	1
Loss of teeth	1							1
Frosted				1				1
Unclassified							1	1
Total	705	270	207	908	290	779	32	3,141

YARDS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	70	2	2	3	9	1	1	88
Bruise	18	58	20	61	84	189		430
Laceration	65		4	129	18	39		255
Puncture	2	3		9	3	9		26
Burn or scald	16	3	3	9	6	11	1	49
Concussion	1							1
Dislocation			3	1		2		6
Fracture	9	15	18	51	18	75		186
Sprain or strain (not hernia)		49	11	14	17	61		152
Accidental dismemberment	1			9	1	1		12
Nervous shock							1	1
Abrasion with infection	15		1	4			1	21
Laceration with infection	1				1			2
Puncture with infection				2				2
Fracture with infection						1		1
Hernia		9						9
Asphyxia							2	2
Electric flash	2							2
Crushing injury	3	12	1	16	4	12	2	50
Heat exhaustion							4	4
Electric shock							1	1
Unclassified	1							1
Total	204	151	63	308	161	401	13	1,301

TABLE 7.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY LOCATION AND NATURE OF INJURY**—Concluded.

SHEET MILLS.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	12					1		**13**
Bruise	5	8	4	38	16	67		**138**
Laceration	20	1	69	133	38	96	1	**358**
Puncture			1	3		4		**8**
Burn or scald	7	4	12	11	6	2		**42**
Concussion	1							**1**
Dislocation				1				**1**
Fracture	2	3		9	6	16		**36**
Sprain or strain (not hernia)		17	6	4	9	38		**74**
Accidental dismemberment	1			13				**14**
Abrasion with infection				14		1		**15**
Laceration with infection			1	3				**4**
Hernia		6						**6**
Crushing injury				4	1			**5**
Total	48	39	93	233	76	225	1	**715**

UNCLASSIFIED.

Nature of injury.	Head and neck.	Trunk.	Arm.	Hand and finger.	Leg.	Foot and toes.	Unclassified.	Total.
Abrasion	264		5	27	27	11		**334**
Bruise	97	278	141	402	343	1,022		**2,283**
Cut	1					1		**2**
Laceration	324	7	75	943	116	275	1	**1,741**
Puncture	25	6	5	56	13	97		**202**
Burn or scald	222	46	81	144	72	95	13	**673**
Concussion	6							**6**
Dislocation			13	11	1	2		**27**
Fracture	38	44	48	188	70	258	2	**648**
Sprain or strain (not hernia)	2	299	66	112	60	212		**751**
Accidental dismemberment	1		1	58	3	5	1	**69**
Nervous shock							2	**2**
Abrasion with infection	29		2	45	3	1		**80**
Cut with infection				2				**2**
Laceration with infection	6		1	28	4	4		**43**
Puncture with infection				11		1		**12**
Burn or scald with infection	4		2	9	2	2		**19**
Hernia		49						**49**
Asphyxia							22	**22**
Electric flash	23							**23**
Crushing injury	2	18		67	6	20	1	**114**
Heat exhaustion							38	**38**
Frosted				1		1		**2**
Unclassified	4	1	1		1		23	**30**
Total	1,048	748	441	2,104	721	2,007	103	**7,172**

TABLE 8.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY.

BLAST FURNACES.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	18	19		2	20	59
Permanent disability: Loss of—						
Both eyes	1					1
1 hand			2			2
1 leg				3		3
1 foot				1		1
1 eye	10					10
1 thumb			2			2
1 finger			11			11
2 fingers			3			3
3 fingers			2			2
4 fingers			1			1
Thumb and 1 finger			1			1
Thumb and 3 fingers			1			1
Great toe				2		2
Any two toes				1		1
All other	1					1
Total	12		23	7		42
Temporary disability: Terminating in—						
1st week	325	105	239	286	65	1,020
2d week	86	46	105	135	7	379
3d week	43	27	66	82	2	220
4th week	16	17	30	56	1	120
5th week	16	10	30	48		104
6th-13th week	16	18	50	51	1	136
14th week and later	3	6	10	27	1	47
All other			1			1
Total	505	229	531	685	77	2,027
Grand total	535	248	554	694	97	2,128

OPEN HEARTHS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	10	20	1	5	11	47
Permanent disability: Loss of—						
Both legs				1		1
1 arm			1			1
1 hand			1			1
1 foot				4		4
1 eye	6					6
1 thumb			9			9
1 finger			26			26
2 fingers			3			3
3 fingers			1			1
4 fingers			1			1
Thumb and 2 fingers			1			1
Thumb and 4 fingers			1			1
Great toe				2		2
Any two toes				2		2
Total	6		44	9		59
Temporary disability: Terminating in—						
1st week	425	160	414	531	40	1,570
2d week	104	73	186	203	4	570
3d week	67	43	123	142	1	376
4th week	28	28	69	85		210
5th week	16	19	62	74	1	172
6th-13th week	38	38	81	128		285
14th week and later	4	9	20	37	2	72
All other			1			1
Total	682	370	956	1,200	48	3,256
Grand total	698	390	1,001	1,214	59	3,362

TABLE 8.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

FOUNDRIES.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	3	4		2	1	10
Permanent disability: Loss of—						
1 hand			1			1
1 leg				1		1
1 eye	1					1
1 thumb			5			5
1 finger			11			11
2 fingers			1			1
3 fingers			1			1
Thumb and 4 fingers			1			1
Great toe				1		1
Any two toes				1		1
Total	1		20	3		24
Temporary disability, terminating in—						
1st week	243	51	253	221	3	771
2d week	48	27	134	136		345
3d week	18	11	58	69	1	157
4th week	5	10	42	51		108
5th week	4	9	23	32		68
6th-13th week	5	15	49	74		143
14th week and later	1	3	5	14		23
Total	324	126	564	597	4	1,615
Grand total	328	130	584	602	5	1,649

HEAVY ROLLING MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	7	5		5	5	22
Permanent disability: Loss of—						
1 arm			2			2
1 hand			4			4
1 leg				3		3
1 foot				4		4
1 eye	8					8
1 thumb			6			6
1 finger			29			29
2 fingers			8			8
3 fingers			3			3
Thumb and 2 fingers			1			1
Great toe				11		11
Any 2 toes				3		3
Total	8		53	21		82
Temporary disability, terminating in—						
1st week	270	109	279	462	11	1,131
2d week	54	34	133	152	2	375
3d week	32	18	76	80	1	207
4th week	13	14	44	69	1	141
5th week	10	11	33	64		118
6th-13th week	37	28	71	108		244
14th week and later	7	9	16	38		70
Total	423	223	652	973	15	2,286
Grand total	438	228	705	999	20	2,390

TABLE 8.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

PLATE MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	4	4			2	10
Permanent disability: Loss of—						
1 foot				3		3
1 thumb			7			7
1 finger			13			13
Thumb and 3 fingers			1			1
Great toe				3		3
Any 2 toes				3		3
Total			21	9		30
Temporary disability, terminating in—						
1st week	148	92	270	466	13	989
2d week	34	31	123	143	2	333
3d week	17	15	58	79	1	170
4th week	9	9	33	48		99
5th week	1	5	21	45		72
6th-13th week	6	12	61	68		147
14th week and later	2	4	7	22		35
Total	217	168	573	871	16	1,845
Grand total	221	172	594	880	18	1,885

TUBE MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	3	4	1		1	9
Permanent disability: Loss of—						
Both eyes	1					1
1 eye	2					2
1 thumb			5			5
1 finger			14			14
2 fingers			4			4
Thumb and 2 fingers			1			1
Any 2 toes				2		2
Total	3		24	2		29
Temporary disability, terminating in—						
1st week	64	21	64	54	6	209
2d week	27	18	49	41	2	137
3d week	9	8	25	27	1	70
4th week	5	12	18	16		51
5th week	4	1	13	13		31
6th-13th week	7	12	23	18		60
14th week and later	2	4	6	14		26
Total	118	76	198	183	9	584
Grand total	124	80	223	185	10	622

TABLE 8.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

FABRICATING.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	3	3		1	2	9
Permanent disability: Loss of—						
1 leg				1		1
1 eye	2					2
1 thumb			5			5
1 finger			34			34
2 fingers			3			3
3 fingers			1			1
Great toe				2		2
Any 2 toes				2		2
Total	2		43	5		50
Temporary disability, terminating in—						
1st week	298	33	180	184	2	697
2d week	70	17	162	142		391
3d week	14	7	96	63		180
4th week	5	3	40	36		84
5th week	5	6	23	26		60
6th-13th week	8	7	35	41		91
14th week and later	2	1	5	12		20
All other				2		2
Total	402	74	541	506	2	1,525
Grand total	407	77	584	512	4	1,584

ELECTRICAL.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	6	2			4	12
Permanent disability: Loss of—						
Both eyes	1					1
1 arm			1			1
1 finger			4			4
2 fingers			3			3
Thumb and 3 fingers			1			1
Great toe				1		1
Total	1		9	1		11
Temporary disability, terminating in—						
1st week	101	15	58	64	5	243
2d week	8	5	41	21	2	77
3d week	7	3	23	11		44
4th week	5	3	9	5		22
5th week	2	2	8	9		21
6th-13th week	8	6	15	21		50
14th week and later	1	2	1	5		9
Total	132	36	155	136	7	466
Grand total	139	38	164	137	11	489

TABLE 8.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Continued.

MECHANICAL.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	9	9	1	1	3	23
Permanent disability: Loss of—						
1 hand			2			2
1 leg				2		2
1 foot				2		2
1 eye	13					13
1 thumb			11			11
1 finger			28			28
2 fingers			4			4
3 fingers			1			1
Thumb and 1 finger			2			2
Thumb and 2 fingers			1			1
Great toe				3		3
Total	13		49	7		69
Temporary disability, terminating in—						
1st week	504	144	445	500	25	1,618
2d week	82	45	232	183	2	544
3d week	35	17	133	108	1	294
4th week	19	16	83	84		202
5th week	17	12	55	46		130
6th-13th week	24	22	102	108		256
14th week and later	2	6	15	32		55
Total	683	262	1,065	1,061	28	3,099
Grand total	705	271	1,115	1,069	31	3,191

YARDS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	8	15		4	3	30
Permanent disability: Loss of—						
1 arm			2			2
1 leg				2		2
1 foot				6		6
1 eye	6					6
1 thumb			4			4
1 finger			19			19
2 fingers			2			2
Great toe				1		1
Any two toes				2		2
Total	6		27	11		44
Temporary disability, terminating in—						
1st week	138	59	154	230	6	587
2d week	28	22	53	96	1	200
3d week	10	18	37	50		115
4th week	2	10	28	38		78
5th week	2	6	19	37	1	65
6th-13th week	10	18	45	72	1	146
14th week and later		4	9	23		36
Total	190	137	345	546	9	1,227
Grand total	204	152	372	561	12	1,301

TABLE 8.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY LOCATION AND RESULT OF INJURY—Concluded.

SHEET MILLS.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Permanent disability: Loss of—						
1 eye	1					1
1 thumb			1			1
1 finger			11			11
2 fingers			2			2
4 fingers			1			1
Total	1		15			16
Temporary disability, terminating in—						
1st week	23	16	95	107	1	242
2d week	13	8	102	69		192
3d week	6	2	46	46		100
4th week	1	4	31	19		55
5th week		5	16	11		32
6th-13th week	4	4	19	40		67
14th week and later			2	9		11
Total	47	39	311	301	1	699
Grand total	48	39	326	301	1	715

UNCLASSIFIED.

Result of injury.	Head and neck.	Trunk.	Upper extremities.	Lower extremities.	Unclassified.	Total.
Death	17	30		7	14	68
Permanent disability: Loss of—						
1 arm			4			4
1 hand			3			3
1 leg				7		7
1 foot				5		5
1 eye	18					18
1 thumb			22			22
1 finger			60			60
2 fingers			8			8
3 fingers			2			2
4 fingers			3			3
Great toe				2		2
Any two toes				6		6
All other				1		1
Total	18		102	21		141
Temporary disability, terminating in—						
1st week	670	329	1,021	1,215	50	3,285
2d week	150	155	551	510	11	1,377
3d week	82	66	323	343	10	824
4th week	33	45	181	173	4	436
5th week	20	45	143	142	1	351
6th-13th week	42	69	208	250	9	578
14th week and later	17	9	18	66	2	112
Total	1,014	718	2,445	2,699	87	6,963
Grand total	1,049	748	2,547	2,727	101	7,172

TABLE 9.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY.

BLAST FURNACES.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All others.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						1				1	196	198
Bruise	1				1					1	526	528
Cut											1	1
Laceration	1					3	2			5	307	313
Puncture						1	1			2	62	64
Burn or scald	13	1				4				5	408	426
Concussion									1	1	1	2
Dislocation											9	9
Fracture	20				1	1	3	1		6	184	210
Sprain or strain (not hernia)											190	190
Accidental dismemberment	1						10	1		11	1	13
Nervous shock											2	2
Abrasion with infection											24	24
Cut with infection							1			1		1
Laceration with infection											11	11
Puncture with infection											3	3
Burn or scald with infection											4	4
Fracture with infection											1	1
Hernia											9	9
Asphyxia	9										66	75
Electric flash		1								1	9	10
Crushing injury	12				1		5	2		8	2	22
Electric shock	1											1
Loss of teeth											1	1
Other	1										11	12
Total	59	2			3	10	22	4	1	42	2,027	2,128

OPEN HEARTHS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All others.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											176	176
Bruise	1					1				1	850	852
Cut											2	2
Laceration						2				2	687	689
Puncture						1				1	65	66
Burn or scald	14					2	2			4	747	765
Concussion											4	4
Dislocation											7	7
Fracture	13						7	3		10	275	298
Sprain or strain (not hernia)											299	299
Accidental dismemberment							19	2		21		21
Nervous shock											3	3
Abrasion with infection	1						1			1	35	37
Laceration with infection											10	10
Puncture with infection											3	3
Burn or scald with infection											6	6
Hernia											9	9
Asphyxia											25	25
Electric flash											18	18
Crushing injury	18		1	1			14	3		19	16	53
Heat exhaustion											17	17
Electric shock											1	1
Other											1	1
Total	47		1	1		6	43	8		59	3,256	3,362

TABLE 9.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Continued.

FOUNDRIES.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All others.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						1				1	195	196
Bruise											518	518
Laceration							3	1		4	370	374
Puncture											64	64
Burn or scald	3										160	163
Dislocation											2	2
Fracture	3				1		5	1		7	137	147
Sprain or strain (not hernia)											118	118
Accidental dismemberment							3			3	1	4
Abrasion with infection							2			2	12	14
Laceration with infection											4	4
Puncture with infection											2	2
Burn or scald with infection											2	2
Hernia											13	13
Asphyxia											1	1
Electric flash											6	6
Crushing injury	4						7			7	8	19
Heat exhaustion											2	2
Total	10				1	1	20	2		24	1,615	1,649

HEAVY ROLLING MILLS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All others.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											141	141
Bruise											724	724
Laceration					1	2	1	1		5	534	539
Puncture						3				3	30	33
Burn or scald	6					2				2	224	232
Concussion	1										2	3
Dislocation											7	7
Fracture	3			1	1		16	5		23	300	326
Sprain or strain (not hernia)				1						1	239	240
Accidental dismemberment							13	4		17		17
Nervous shock									1	1	1	2
Abrasion with infection											22	22
Laceration with infection	1					1				1	5	7
Puncture with infection											2	2
Burn or scald with infection											4	4
Fracture with infection							1			1	1	2
Hernia											7	7
Asphyxia											1	1
Electric flash											20	20
Crushing injury	11				1		20	7		28	7	46
Heat exhaustion											10	10
Loss of teeth											1	1
Other											4	4
Total	22			2	3	8	51	17	1	82	2,286	2,390

TABLE 9.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY NATURE AND RESULT OF INJURY**—Continued.

PLATE MILLS.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All others.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion											68	68
Bruise	1										597	598
Cut											2	2
Laceration							1	1		2	530	532
Puncture											101	101
Burn or scald	2										149	151
Concussion											2	2
Dislocation											7	7
Fracture	5						1	2		3	156	164
Sprain or strain (not hernia)											160	160
Accidental dismemberment							11	3		14	1	15
Nervous shock									1	1		1
Abrasion with infection											12	12
Cut with infection											1	1
Laceration with infection											4	4
Puncture with infection											3	3
Burn or scald with infection											1	1
Hernia											7	7
Asphyxia											1	1
Electric flash											18	18
Crushing injury							7	3		10	8	18
Heat exhaustion	2										15	17
Loss of teeth											2	2
Total	10						20	9	1	30	1,845	1,885

TUBE MILLS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All others.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											54	54
Bruise	2										150	152
Cut											3	3
Laceration		1				1	2			4	151	155
Puncture											17	17
Burn or scald	1										53	54
Concussion	1											1
Dislocation											2	2
Fracture							2			2	85	87
Sprain or strain (not hernia)											36	36
Accidental dismemberment						1	6			7		7
Abrasion with infection	1										4	5
Laceration with infection											7	7
Puncture with infection											1	1
Burn or scald with infection											1	1
Hernia											6	6
Electric flash											1	1
Crushing injury	3						14	2		16	5	24
Heat exhaustion	1										5	6
Other											3	3
Total	9	1				2	24	2		29	584	622

TABLE 9.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Continued.

FABRICATING.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All others.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion											202	202
Bruise					1					1	310	311
Cut											1	1
Laceration						1	2			3	528	531
Puncture						1				1	46	47
Burn or scald	1										43	44
Dislocation							1			1	7	8
Fracture	3						7	1		8	257	268
Sprain or strain (not hernia)											99	99
Accidental dismemberment							10			10		10
Abrasion with infection											9	9
Cut with infection											1	1
Laceration with infection							1			1	5	6
Burn or scald with infection											2	2
Hernia											4	4
Asphyxia											1	1
Electric flash											1	1
Crushing injury	4						22	3		25	7	36
Loss of teeth											1	1
Other	1										1	2
Total	9				1	2	43	4		50	1,525	1,584

ELECTRICAL.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All others.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											42	42
Bruise											82	82
Laceration							1			1	82	83
Puncture											13	13
Burn or scald	1	1								1	80	82
Dislocation											2	2
Fracture	5										41	46
Sprain or strain (not hernia)											58	58
Accidental dismemberment							3			3		3
Abrasion with infection											7	7
Laceration with infection											2	2
Puncture with infection							1			1	2	3
Hernia											3	3
Asphyxia	1										2	3
Electric flash											38	38
Crushing injury	2			1			3	1		5	6	13
Heat exhaustion											4	4
Electric shock	3										1	4
Loss of teeth											1	1
Total	12	1		1			8	1		11	466	489

TABLE 9.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, **BY NATURE AND RESULT OF INJURY**—Continued.

MECHANICAL.

Nature of injury.	Death.	Permanent disabilities.									Temporary disabilities.	Gr'nd total.
		Loss of—							All others.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion						1				1	334	335
Bruise						1				1	902	903
Cut											1	1
Laceration						4	2			6	721	727
Puncture	1					5				5	121	127
Burn or scald	1										203	204
Concussion											2	2
Dislocation											17	17
Fracture	8						6	2		8	323	339
Sprain or strain (not hernia)											303	303
Accidental dismemberment							26			26	3	29
Nervous shock	1										4	5
Abrasion with infection						2				2	60	62
Laceration with infection	2										17	19
Puncture with infection											6	6
Burn or scald with infection											2	2
Hernia											26	26
Asphyxia	1										18	19
Electric flash											7	7
Crushing injury	8				2		15	3		20	20	48
Heat exhaustion											6	6
Electric shock	1											1
Loss of teeth											1	1
Frosted											1	1
Other											1	1
Total	23				2	13	49	5		69	3,099	3,191

YARDS.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All others.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion											87	87
Bruise											430	430
Laceration						5				5	250	255
Puncture	2										24	26
Burn or scald	1										48	49
Concussion											1	1
Dislocation											6	6
Fracture	5			1	1		4	1		7	174	186
Sprain or strain (not hernia)											152	152
Accidental dismemberment	2						8	1		9	1	12
Nervous shock											1	1
Abrasion with infection	1					1				1	20	22
Laceration with infection											2	2
Puncture with infection											2	2
Fracture with infection	1											1
Hernia											9	9
Asphyxia											2	2
Electric flash											2	2
Crushing injury	18			1	1		13	7		22	10	50
Heat exhaustion											4	4
Electric shock											1	1
Other											1	1
Total	30			2	2	6	25	9		44	1,227	1,301

TABLE 9.—NUMBER OF CASES OF ACCIDENT IN SPECIFIED DEPARTMENTS OF THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY NATURE AND RESULT OF INJURY—Concluded.

SHEET ROLLING MILLS.

Nature of injury.	Death.	Permanent disability.									Temporary disabilities.	Gr'nd total.
		Loss of—							All others.	Total.		
		Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.				
Abrasion											13	13
Bruise											138	138
Laceration											358	358
Puncture											8	8
Burn or scald											42	42
Concussion											1	1
Dislocation											1	1
Fracture											36	36
Sprain or strain (not hernia)											74	74
Accidental dismemberment						1	12			13	1	14
Abrasion with infection											15	15
Laceration with infection							1			1	3	4
Hernia											6	6
Crushing injury							2			2	3	5
Total						1	15			16	699	715

UNCLASSIFIED.

Nature of injury.	Death.	Both eyes.	Both legs.	Arm.	Leg.	Eye.	Hand or fingers.	Foot or toes.	All others.	Total.	Temporary disabilities.	Gr'nd total.
Abrasion						2				2	332	334
Bruise	1										2,282	2,283
Cut											2	2
Laceration	1					4	4		1	9	1,731	1,741
Puncture	2					9	1			10	190	202
Burn or scald	10					1		2		3	660	673
Concussion	1										5	6
Dislocation											27	27
Fracture	18			2	3		7			12	618	648
Sprain or strain (not hernia)											751	751
Accidental dismemberment	2			2	1		55	5		63	4	69
Nervous shock											2	2
Abrasion with infection						1				1	79	80
Cut with infection											2	2
Laceration with infection	1										42	43
Puncture with infection											12	12
Burn or scald with infection						1				1	18	19
Hernia											49	49
Asphyxia	5										17	22
Electric flash											23	23
Crushing injury	26				3		31	6		40	48	114
Heat exhaustion											38	38
Frosted											2	2
Other	1										29	30
Total	68			4	7	18	98	13	1	141	6,963	7,172

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY.**

THE INDUSTRY.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	1,524	1,420	87	159	523	423	228
Permanent disability: Loss of—							
Both arms	3	1		1			
Both legs	2	6		2	3		1
Both hands	1	1			1		
Both feet	3	3			1	1	1
Both eyes	10	6		2	2	1	1
1 arm	66	52	1	10	19	14	8
1 hand	100	98	6	11	29	25	17
1 leg	106	82	4	8	29	28	13
1 foot	129	121	6	5	48	43	19
1 eye	479	429	33	60	135	150	51
1 thumb	415	320	28	43	108	99	42
1 finger	2,506	1,593	137	304	533	470	149
2 fingers		154			54	65	35
3 fingers		51			11	26	14
4 fingers		21			9	7	5
Thumb and 1 finger		12			4	6	2
Thumb and 2 fingers		6			3	1	2
Thumb and 3 fingers		5			1	2	2
Thumb and 4 fingers		7			3	2	2
Great toe	172	115	8	17	46	37	7
Any 2 toes	244	139	18	28	53	28	12
All other	844	797	134	237	176	196	54
Total	5,080	4,016	375	728	1,268	1,211	437
Temporary disability, terminating in—							
1st week	118,215	84,229	7,150	9,410	29,058	24,734	13,877
2d week	49,521	32,437	2,740	4,592	11,801	8,627	4,677
3d week	21,854	15,472	1,335	2,235	5,387	4,209	2,306
4th week	11,883	9,472	759	1,418	3,399	2,588	1,308
5th week	7,282	6,165	453	937	2,203	1,621	951
6th-13th week	12,671	11,063	901	1,662	3,861	2,913	1,726
14th week or later	2,717	2,201	179	383	818	556	265
All other	2,162	1,625	7	18	567	843	190
Total	226,305	162,664	13,524	20,655	57,094	46,091	25,300
Grand total	232,909	168,100	13,986	21,542	58,885	47,725	25,965
Number of workers	*1,310,911*	*1,335,305*	*116,224*	*166,646*	*410,852*	*392,260*	*249,323*

BLAST FURNACES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	324	264	19	23	79	90	53
Permanent disability: Loss of—							
Both arms		1		1			
Both egs		3			2		1
Both feet	1						
Both eyes	7	2				1	1
1 arm	9	8			2	4	2
1 hand	13	5		1	1	2	1
1 leg	14	9	1	1	2	4	1
1 foot	7	10	1		6	2	1
1 eye	45	42	1	5	13	14	9
1 thumb	11	20	2	3	5	10	
1 finger	152	80	8	15	29	17	11
2 fingers		12			2	3	7
3 fingers		5			2	3	
4 fingers		2			2		
Thumb and 1 finger		1					1
Thumb and 2 fingers		1					1
Thumb and 4 fingers		1				1	
Great toe	10	6			4	2	
Any 2 toes	15	8	2	3	1	1	1
All other	80	69	8	29	22	5	5
Total	364	285	23	58	93	69	42

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY DEPARTMENTS AND RESULT OF INJURY—Continued.

BLAST FURNACES—Continued.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Temporary disability, terminating in—							
1st week	11,198	6,599	527	800	2,186	1,700	1,386
2d week	4,737	2,824	189	376	924	807	528
3d week	2,308	1,375	96	201	458	389	231
4th week	1,182	781	45	115	279	221	121
5th week	824	601	39	95	213	147	107
6th-13th week	1,459	929	63	123	294	282	167
14th week and later	380	210	22	50	44	67	27
All other	488	92	....	3	42	42	5
Total	22,576	13,411	981	1,763	4,440	3,655	2,572
Grand total	23,264	13,962	1,023	1,844	4,614	3,814	2,667
Number of workers	*124,636*	*123,669*	*10,721*	*14,905*	*36,202*	*31,904*	*29,937*

BESSEMER.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	56	48	2	13	20	7	6
Permanent disability: Loss of—							
1 leg	3	3	....	1	1	1	....
1 foot	4	2	....	1	1	....	....
1 eye	21	11	1	4	5	1	....
1 thumb	13	7	3	1	1	....	2
1 finger	65	28	7	7	8	6	....
2 fingers	....	2	....	....	1	1	....
Thumb and 1 finger	....	1	....	....	....	1	....
Great toe	4	5	1	2	....	2	....
Any 2 toes	8	7	1	4	1	1	....
All other	27	27	8	14	3	2	....
Total	145	93	21	34	21	15	2
Temporary disability, terminating in—							
1st week	3,283	1,390	231	334	443	185	197
2d week	1,707	674	72	179	240	110	73
3d week	823	441	61	112	156	58	54
4th week	524	301	46	72	111	44	28
5th week	295	203	33	49	73	29	19
6th-13th week	614	358	46	86	136	48	42
14th week and later	90	73	5	15	28	14	11
All other	30	10	....	1	7	1	1
Total	7,366	3,450	494	848	1,194	489	425
Grand total	7,567	3,591	517	895	1,235	511	433
Number of workers	*28,101*	*21,557*	*3,160*	*4,071*	*5,979*	*3,596*	*4,751*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY DEPARTMENTS AND RESULT OF INJURY—Continued.

OPEN HEARTHS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	141	146	8	12	47	53	26
Permanent disability: Loss of—							
Both feet	1	1			1		
Both eyes		1		1			
All other		2				1	1
1 arm	5	2			1	1	
1 hand	7	5	1			1	3
1 leg	13	8			1	3	4
1 foot	18	19			10	7	2
1 eye	14	18	2	3	8	2	3
1 thumb	28	24	2	3	7	8	4
1 finger	171	95	5	16	34	32	8
2 fingers		8				8	
3 fingers		3				3	
4 fingers		2				1	1
Great toe	16	11		2	2	6	1
Any 2 toes	18	19	3	4	7	5	
All other	37	45	7	8	15	14	1
Total	328	265	20	37	86	92	30
Temporary disability, terminating in—							
1st week	7,736	4,735	435	631	1,411	1,399	859
2d week	3,447	1,940	142	290	616	607	285
3d week	1,559	1,093	98	178	352	316	149
4th week	961	682	41	104	247	219	71
5th week	536	523	46	83	175	149	70
6th-13th week	990	858	55	136	298	243	126
14th week and later	207	203	14	35	77	57	20
All other	131	39	1	1	11	23	3
Total	15,567	10,073	832	1,458	3,187	3,013	1,583
Grand total	16,036	10,484	860	1,507	3,320	3,158	1,639
Number of workers	*71,293*	*72,271*	*5,969*	*9,654*	*21,457*	*20,681*	*14,510*

CRUCIBLE FURNACES.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death		1				1	
Permanent disability: Loss of—							
1 eye		2			1	1	
1 finger		4				2	2
2 fingers		1				1	
3 fingers		2					2
All other		2				2	
Total		11			1	6	4
Temporary disability, terminating in—							
1st week		326			126	166	34
2d week		117			52	55	10
3d week		66			23	37	6
4th week		49			19	25	5
5th week		32			13	19	
6th-13th week		49			13	27	9
14th week and later		8			1	7	
All other		20			14	5	1
Total		667			261	341	65
Grand total		679			262	348	69
Number of workers		*4,168*			*1,197*	*2,372*	*599*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY**—Continued.

FOUNDRIES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	84	74	....	1	45	22	6
Permanent disability: Loss of—							
Both eyes	....	1	....	....	1	....	....
1 arm	4	2	....	....	1	1	....
1 hand	4	5	....	....	....	3	2
1 leg	5	12	....	....	5	5	2
1 foot	12	6	....	....	4	2	....
1 eye	43	35	....	....	10	17	8
1 thumb	42	20	....	1	10	7	2
1 finger	210	107	1	2	29	50	16
2 fingers	....	21	....	....	10	8	3
3 fingers	....	4	....	....	3	....	1
Thumb and 3 fingers	....	1	....	....	....	....	1
Great toe	23	8	....	....	6	2	....
Any 2 toes	22	14	1	2	4	4	3
All other	86	29	....	1	18	7	3
Total	451	256	2	6	101	106	41
Temporary disability, terminating in—							
1st week	10,447	8,652	57	53	4,199	2,995	1,348
2d week	3,177	2,391	20	30	1,073	932	336
3d week	1,515	1,268	15	17	555	518	163
4th week	766	775	13	14	325	309	114
5th week	498	493	3	8	195	219	68
6th-13th week	856	748	10	21	304	308	105
14th week and later	258	103	....	2	55	29	17
All other	249	169	....	....	104	59	6
Total	17,766	14,599	118	145	6,810	5,369	2,157
Grand total	18,301	14,929	120	152	6,956	5,497	2,204
Number of workers	*95,917*	*80,029*	*1,309*	*1,231*	*31,805*	*32,186*	*13,498*

BAR MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	....	20	1	4	8	6	1
Permanent disability: Loss of—							
1 arm	....	3	1	....	1	....	1
1 hand	....	1	....	....	1	....	....
1 foot	....	1	....	....	....	1	....
1 eye	....	7	....	....	4	3	....
1 thumb	....	3	....	....	1	1	1
1 finger	....	45	5	6	22	11	1
2 fingers	....	1	....	....	1	....	....
Great toe	....	1	....	....	1	....	....
Any 2 toes	....	4	....	....	3	....	1
All other	....	7	1	5	....	....	1
Total	....	73	7	11	34	16	5
Temporary disability, terminating in—							
1st week	....	2,537	341	400	1,142	381	273
2d week	....	830	86	155	355	126	108
3d week	....	429	51	81	186	62	49
4th week	....	230	42	56	77	36	19
5th week	....	137	18	26	55	19	19
6th-13th week	....	275	33	57	102	44	39
14th week and later	....	37	4	8	18	7	....
All other	....	12	2	....	5	7	....
Total	....	4,489	577	783	1,940	682	507
Grand total	....	4,582	585	798	1,982	704	513
Number of workers	....	*20,992*	*3,232*	*3,042*	*7,472*	*3,439*	*3,807*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910–1914 AND 1915–1919, AND BY YEARS, 1915 TO 1919, BY DEPARTMENTS AND RESULT OF INJURY—Continued.

HEAVY ROLLING MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	71	75	10	7	30	20	8
Permanent disability: Loss of—							
Both feet		1				1	
1 arm	3						
1 hand	5	12		3	3	5	1
1 leg	5	7	2	2	1		2
1 foot	11	8	1	1	2	2	2
1 eye	17	15	1	3	6	4	1
1 thumb	18	27	2	5	9	9	2
1 finger	144	98	8	19	33	33	5
2 fingers		9			2	4	3
3 fingers		2			2		
Thumb and 1 finger		1			1		
Great toe	12	16		4	11	1	
Any 2 toes	20	7			7		
Other	26	38	10	7	10	8	3
Total	261	241	24	44	87	67	19
Temporary disability, terminating in—							
1st week	4,461	2,721	327	404	656	764	570
2d week	1,785	1,160	97	197	445	258	163
3d week	908	587	55	117	207	127	81
4th week	526	378	41	68	130	89	50
5th week	364	286	25	53	98	70	40
6th–13th week	648	488	40	100	186	95	67
14th week and later	166	135	10	20	57	32	16
All other	147	20	1		5	3	11
Total	9,005	5,775	596	959	1,784	1,438	998
Grand total	9,337	6,091	630	1,010	1,901	1,525	1,025
Number of workers	*67,663*	*62,957*	*7,148*	*10,076*	*20,530*	*13,788*	*11,415*

PLATE MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	19	20	1	3	4	5	7
Permanent disability: Loss of—							
Both feet	1						
1 arm	2						
1 hand	3	3		1	1	1	
1 leg		1			1		
1 foot	4	2			1	1	
1 eye	6	6		1		3	2
1 thumb	4	9	2	3	1	2	1
1 finger	64	34	5	5	9	10	5
2 fingers		3			1		2
3 fingers		1			1		
Thumb and 1 finger		1				1	
Thumb and 4 fingers		1					1
Great toe	3	4		1	1	1	1
Any 2 toes	7	4	1	1	1		1
All other	11	9	1	3	5		
Total	105	78	9	15	22	19	13
Temporary disability terminating in—							
1st week	1,533	1,468	52	175	381	514	346
2d week	683	597	26	100	159	167	145
3d week	343	305	13	39	71	111	71
4th week	197	231	15	40	53	78	45
5th week	111	152	6	31	34	46	35
6th–13th week	210	247	9	47	56	80	55
14th week and later	51	41		3	12	15	11
All other	9	21		1		20	
Total	3,137	3,062	121	436	766	1,031	708
Grand total	3,261	3,160	131	454	792	1,055	728
Number of workers	*21,711*	*30,505*	*2,086*	*4,681*	*6,764*	*9,302*	*7,672*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY DEPARTMENTS AND RESULT OF INJURY—Continued.

PUDDLING MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	9	4			1	3	
Permanent disability: Loss of—							
1 arm	1						
1 hand	2						
1 eye	5	3			2	1	
1 thumb	3	3			1	2	
1 finger	43	3			2	1	
2 fingers		3			3		
Great toe	1	1			1		
Any 2 toes	1	1			1		
All other	1						
Total	57	14			10	4	
Temporary disability, terminating in—							
1st week	882	508			295	178	35
2d week	347	197			114	68	15
3d week	145	107			66	38	3
4th week	79	55			25	25	5
5th week	65	39			21	13	5
6th-13th week	96	70			40	26	4
14th week and later	22	10			7	2	1
All other	45	31			4	20	7
Total	1,681	1,017			572	370	75
Grand total	1,747	1,035			583	377	75
Number of workers	*12,788*	*7,600*			*4,129*	*2,712*	*759*

SHEET MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	87	54	7	13	28	3	3
Permanent disability: Loss of—							
Both hands	1	1			1		
1 arm	6	4		1	3		
1 hand	14	10	1	2	3	3	1
1 leg	6	4		1	2	1	
1 foot	6	10	2	2	3	2	1
1 eye	16	16		2	10	2	2
1 thumb	35	17	3	6	8		
1 finger	206	104	15	45	36	6	2
2 fingers		8			4	3	1
3 fingers		1			1		
4 fingers		2			1		1
Thumb and 1 finger		1			1		
Thumb and 2 fingers		1			1		
Thumb and 3 fingers		1			1		
Great toe	13	3		1	2		
Any 2 toes	15	6	2	2	2		
All other	21	17			1		16
Total	339	206	23	62	80	17	24
Temporary disability, terminating in—							
1st week	10,540	5,504	838	987	2,485	492	702
2d week	4,664	3,377	535	780	1,432	185	445
3d week	1,611	1,585	234	359	666	104	222
4th week	862	790	103	189	336	48	114
5th week	492	458	70	110	194	33	51
6th-13th week	781	768	94	200	326	54	94
14th week and later	237	145	27	28	70	6	14
All other	73	41		2	24	15	
Total	19,260	12,671	1,901	2,655	5,533	937	1,645
Grand total	19,686	12,931	1,931	2,730	5,641	957	1,672
Number of workers	*128,423*	*121,355*	*16,266*	*24,722*	*46,040*	*17,278*	*17,049*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY DEPARTMENTS AND RESULT OF INJURY—Continued.

TUBE MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	37	35	2	2	17	8	6
Permanent disability: Loss of—							
1 arm	3	1					1
1 hand	2	5			2	1	2
1 leg	1						
1 foot	2	1			1		
1 eye	9	11	1	2	2	2	4
1 thumb	34	21	2	3	8	5	3
1 finger	129	85	8	17	28	24	8
2 fingers		8			2	4	2
3 fingers		2				1	1
Thumb and 1 finger		1				1	
Thumb and 4 fingers		1			1		
Great toe	14	4		2	1	1	
Any 2 toes	4	9	3	2	3	1	
All other	50	8	1		3	1	3
Total	248	157	15	26	51	41	24
Temporary disability, terminating in—							
1st week	4,343	2,282	242	89	1,110	535	306
2d week	1,994	935	89	109	359	236	142
3d week	937	455	39	64	161	113	78
4th week	473	364	24	63	114	92	71
5th week	285	220	21	31	72	49	47
6th-13th week	480	379	44	59	126	86	64
14th week and later	98	65	12	10	17	13	13
All other	13	14			8	3	3
Total	8,623	4,714	471	425	1,967	1,127	724
Grand total	8,908	4,907	489	453	2,035	1,176	754
Number of workers	*73,338*	*71,216*	*7,109*	*11,355*	*19,819*	*18,500*	*14,438*

MISCELLANEOUS ROLLING MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	84	42	2	5	10	16	9
Permanent disability: Loss of—							
Both legs	1						
1 arm	9	4		1	2	1	
1 hand	9	5		1	3	1	
1 leg	10	2			1	1	
1 foot	12	4				3	1
1 eye	36	17	1		7	6	3
1 thumb	46	22	2	1	4	10	5
1 finger	167	87	5	18	24	27	13
2 fingers		9			4	4	1
3 fingers		2					2
4 fingers		2			1	1	
Thumb and 2 fingers		1			1		
Great toe	14	6	1		1	4	
Any 2 toes	16	9	1	1	6	1	
All other	43	30	4	3	5	15	3
Total	363	200	14	25	59	74	28
Temporary disability, terminating in—							
1st week	9,698	5,364	266	416	1,908	1,929	845
2d week	5,415	1,967	95	171	800	638	263
3d week	2,531	987	51	98	363	331	144
4th week	1,375	564	22	66	241	170	65
5th week	815	405	11	47	151	116	80
6th-13th week	1,318	762	26	96	293	238	109
14th week and later	209	123	4	26	38	38	17
All other	139	242		2	154	63	23
Total	21,500	10,414	475	922	3,948	3,523	1,546
Grand total	21,947	10,656	491	952	4,017	3,613	1,583
Number of workers	*98,809*	*80,380*	*4,367*	*8,082*	*24,811*	*29,188*	*13,932*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910–1914 AND 1915–1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY**—Continued.

FABRICATING.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	94	57	3	7	21	21	5
Permanent disability: Loss of—							
Both arms	2						
Both eyes		1			1		
1 arm	3	2				2	
1 hand	7	5			2	2	1
1 leg	7	1				1	
1 foot	6	2				1	1
1 eye	47	16	1	1	5	7	2
1 thumb	40	19	2	3	3	6	5
1 finger	252	85	8	17	47	8	5
2 fingers		1					1
3 fingers		1					1
Great toe	17	7		1	1	2	3
Any two toes	12	5	3		2		
All other	28	10	1	3	5		1
Total	421	155	15	25	66	29	20
Temporary disability, terminating in—							
1st week	14,962	7,718	242	267	2,399	3,308	1,502
2d week	5,299	2,411	89	169	816	917	420
3d week	2,080	943	39	84	345	310	165
4th week	1,102	572	24	65	204	188	91
5th week	763	345	21	38	142	79	65
6th-13th week	1,123	641	44	57	212	230	98
14th week and later	160	110	12	23	31	28	16
All other	16	5			2		3
Total	25,505	12,745	471	703	4,151	5,060	2,360
Grand total	26,020	12,957	489	735	4,238	5,110	2,385
Number of workers	*108,538*	*77,078*	*3,818*	*4,980*	*23,382*	*29,167*	*15,732*

FORGES.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	8	6			2	2	2
Permanent disability: Loss of—							
Both legs		1			1		
1 hand		1				1	
1 leg		1			1		
1 foot		2				2	
1 eye	2	3			2	1	
1 thumb	3	1				1	
1 finger	7	12			7	4	1
2 fingers		3			2	1	
3 fingers		1				1	
Thumb and 2 fingers		1			1		
Great toe	1	1			1		
Any 2 toes	2						
All other	4	15				15	
Total	19	42			15	26	1
Temporary disability, terminating in—							
1st week	460	916		3	357	479	77
2d week	310	303			135	147	21
3d week	144	132		1	54	66	11
4th week	63	104			49	53	2
5th week	28	57			28	25	4
6th-13th week	40	93		2	46	38	7
14th week and later	8	14			7	6	1
All other	27	8				8	
Total	1,080	1,627		6	676	822	123
Grand total	1,107	1,675		6	693	850	126
Number of workers	*6,249*	*10,577*		*209*	*2,728*	*6,408*	*1,232*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY**—Continued.

ROD MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death		13			7	5	1
Permanent disability: Loss of—							
1 arm		1				1	
1 foot		3			2		1
1 eye		9		2	4	1	2
1 thumb		3		1	1		1
1 finger		16	1	2	8	2	3
3 fingers		1					1
Great toe		3	1		1	1	
Any 2 toes		3		1	1	1	
All other		30	8	10	6	5	1
Total		69	10	16	23	11	9
Temporary disability, terminating in—							
1st week		771	112	113	356	130	60
2d week		421	49	67	174	96	35
3d week		158	23	29	54	41	11
4th week		122	9	20	56	23	14
5th week		56	11	7	20	16	2
6th-13th week		130	22	20	30	30	28
14th week and later		20	3	3	6	5	3
All other		13			3	9	1
Total		1,691	229	259	699	350	154
Grand total		1,773	239	275	729	366	164
Number of workers		*14,894*	*2,062*	*2,493*	*4,951*	*3,249*	*2,139*

WIRE DRAWING.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death		12	1	4	3	4	
Permanent disability: Loss of—							
1 arm		1		1			
1 hand		1	1				
1 leg		1			1		
1 foot		1		1			
1 eye		53	10	11	9	15	8
1 thumb		16	2	5	4	4	1
1 finger		119	14	36	27	29	13
2 fingers		1					1
3 fingers		3				1	2
Great toe		5	2		1	1	1
Any 2 toes		4	1	1	1	1	
All other		112	32	49	18	9	4
Total		*317*	*62*	*104*	*61*	*60*	*30*
Temporary disability, terminating in—							
1st week		3,458	1,105	914	785	430	224
2d week		1,553	382	458	410	220	83
3d week		692	154	162	191	127	58
4th week		397	75	102	109	61	50
5th week		227	40	53	69	43	22
6th-13th week		385	61	69	100	86	69
14th week and later		76	14	5	31	22	4
All other		9		1	5	2	1
Total		6,797	1,831	1,764	1,700	991	511
Grand total		7,126	1,894	1,872	1,764	1,055	541
Number of workers		*51,967*	*7,859*	*9,551*	*13,727*	*12,757*	*8,073*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY**—Continued.

ELECTRICAL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	33	35	1	6	16	5	7
Permanent disability: Loss of—							
1 arm	4	1				1	
1 hand	2	1					1
1 leg	1	1			1		
1 foot	2	2			1	1	
1 eye	4	3			2	1	
1 thumb	2	1			1		
1 finger	21	17	1	6	4	5	1
2 fingers		2			2		
4 fingers		1			1		
Thumb and 1 finger		1			1		
Thumb and 3 fingers		1					1
Great toe	1	1			1		
Any 2 toes	6	1			1		
All other	5	1			1		
Total	48	34	1	6	16	8	3
Temporary disability, terminating in—							
1st week	1,129	809	20	172	293	183	141
2d week	388	238	1	42	123	31	41
3d week	161	104	1	23	43	17	20
4th week	82	60		15	30	9	6
5th week	50	54		13	23	5	13
6th-13th week	114	86		17	40	12	17
14th week and later	26	28	1	6	18	1	2
All other	7	2		1	1		
Total	1,957	1,381	23	289	571	258	240
Grand total	2,038	1,450	25	301	603	271	250
Number of workers	*14,421*	*12,988*	*612*	*1,035*	*4,385*	*3,801*	*2,555*

MECHANICAL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	102	124	3	9	43	42	27
Permanent disability: Loss of—							
Both legs		1		1			
1 arm	3	8		3	3		2
1 hand	9	9		2	4	2	1
1 leg	6	7		1	1	4	1
1 foot	6	12			5	6	1
1 eye	47	49		10	11	25	3
1 thumb	27	34	2	2	15	10	5
1 finger	179	175	10	29	67	52	17
2 fingers		13			4	7	2
3 fingers		10				7	6
4 fingers		1				1	
Thumb and 1 finger		3			1	2	
Thumb and 3 fingers		1				1	
Thumb and 4 fingers		1				1	
Great toe	11	5		1	1	2	1
Any 2 toes	23	13		2	4	6	1
All other	81	99	15	35	18	28	3
Total	392	441	27	86	134	154	40
Temporary disability, terminating in—							
1st week	9,289	7,935	326	1,148	2,564	2,448	1,449
2d week	4,021	2,775	116	429	1,097	721	412
3d week	1,655	1,223	48	202	459	325	189
4th week	911	829	23	150	318	217	121
5th week	547	553	12	114	231	123	73
6th-13th week	1,059	1,022	39	160	422	195	206
14th week and later	234	189	8	39	87	38	17
All other	78	45	1	3	23	15	3
Total	17,794	14,571	573	2,245	5,201	4,082	2,470
Grand total	18,288	15,136	603	2,340	5,378	4,278	2,537
Number of workers	*97,162*	*137,257*	*5,987*	*16,920*	*33,328*	*58,003*	*23,019*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY**—Continued.

POWER HOUSES.

Reult of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	6	11			5	6	
Permanent disability: Loss of—							
Both eyes	1						
1 hand		1			1		
1 leg	2	1			1		
1 foot		1			1		
1 eye		2		1		1	
1 thumb	2						
1 finger	14	6		1	1	4	
2 fingers		3			2	1	
4 fingers		1			1		
Any 2 toes	1						
All other	1	4				4	
Total	21	19		2	7	10	
Temporary disability, terminating in—							
1st week	282	206	4	21	71	65	45
2d week	108	93		10	40	22	21
3d week	63	39		6	8	10	15
4th week	25	29		8	5	10	6
5th week	17	23		5	7	5	6
6th-13th week	35	44		6	14	9	15
14th week and later	8	9		2	5	2	
All other	6	1				1	
Total	544	444	4	58	150	124	108
Grand total	571	480	4	60	162	140	114
Number of workers	*8,083*	*11,099*	*195*	*680*	*3,837*	*3,366*	*3,021*

COKE.

Reult of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	27	38	2	5	16	9	6
Permanent disability: Loss of—							
1 arm	4	2			1		1
1 hand	1	2			1	1	
1 leg	3	1					1
1 foot	3						
1 eye	4	2	1	1			
1 thumb	1	2					2
1 finger	9	17	2	2	5	6	2
2 fingers		2			2		
4 fingers		1				1	
Great toe	1	2		2			
Any 2 toes	3	1		1			
All other	10	4	1		1	1	1
Total	39	36	4	6	10	9	7
Temporary disability, terminating in—							
1st week	921	810	88	88	220	199	215
2d week	295	267	15	16	101	63	72
3d week	140	121	5	14	44	34	24
4th week	72	72	6	8	22	22	14
5th week	66	50	6	5	12	14	13
6th-13th week	112	94	5	11	25	25	28
14th week and later	31	28	1	6	8	9	4
All other	14	6	2	2	2		
Total	1,651	1,448	128	150	434	366	370
Grand total	1,717	1,521	134	161	460	384	382
Number of workers	*13,282*	*23,263*	*1,648*	*2,195*	*5,538*	*7,368*	*6,514*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY DEPARTMENTS AND RESULT OF INJURY—Continued.

YARDS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	112	78		12	36	23	7
Permanent disability: Loss of—							
Both eyes		1		1			
1 arm	3	5		2	2	1	
1 hand	1	8			4	4	
1 leg	17	7			4	1	2
1 foot	11	10	1		3	2	4
1 eye	14	15	1	4	5	3	2
1 thumb	20	13	1	3	6	2	1
1 finger	105	78	3	20	26	20	9
2 fingers		4			1	2	1
3 fingers		4				3	1
4 fingers		2			1	1	
Thumb and 3 fingers		1				1	
Thumb and 4 fingers		1			1		
Great toe	5	7		1	2	3	1
Any 2 toes	18	11		1	3	4	3
All other	50	65	9	24	19	13	
Total	244	232	15	56	77	60	24
Temporary disability, terminating in—							
1st week	4,211	2,440	250	477	904	572	237
2d week	1,766	969	71	195	396	237	70
3d week	771	397	28	92	137	102	38
4th week	408	271	24	42	93	86	26
5th week	296	175	12	30	63	52	18
6th-13th week	549	410	29	75	143	110	53
14th week and later	108	90	3	18	36	24	9
All other	44	44			20	15	9
Total	8,153	4,796	417	929	1,792	1,198	460
Grand total	8,509	5,111	432	997	1,905	1,281	496
Number of workers	*55,932*	*47,685*	*3,843*	*7,853*	*15,732*	*16,355*	*3,902*

ERECTION OF STRUCTURAL STEEL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death		45	8	10	12	10	5
Permanent disability: Loss of—							
1 leg		3	1	1		1	
1 foot		3	1		2		
1 eye		5	1		3	1	
1 thumb		4	1	1	2		
1 finger		11	2		6		3
Thumb and 2 fingers		1				1	
Great toe		1	1				
All other		7		1	2		4
Total		35	7	3	15	3	7
Temporary disability, terminating in—							
1st week		834	142	111	239	223	119
2d week		227	38	45	70	47	27
3d week		127	25	22	43	23	14
4th week		80	21	19	16	14	10
5th week		55	6	17	13	10	9
6th-13th week		141	18	24	44	41	14
14th week and later		42	1	13	17	6	5
All other		4					4
Total		1,510	251	251	442	364	202
Grand total		1,590	266	264	469	377	214
Number of workers		*7,477*	*803*	*1,011*	*1,156*	*1,234*	*775*

TABLE 10.—NUMBER OF CASES OF ACCIDENT IN THE IRON AND STEEL INDUSTRY, 1910–1914 AND 1915–1919, AND BY YEARS, 1915 TO 1919, **BY DEPARTMENTS AND RESULT OF INJURY**—Concluded.

SHEET ROLLING MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	....	3	....	....	....	....	3
Permanent disability: Loss of—							
1 foot	....	1	....	....	....	1	....
1 eye	....	1	....	....	....	1	....
1 thumb	....	1	....	....	....	1	....
1 finger	....	4	....	....	....	2	2
All other	....	3	....	....	....	....	3
Total	....	10	....	....	....	5	5
Temporary disability, terminating in—							
1st week	....	332	....	....	....	129	203
2d week	....	133	....	....	....	27	106
3d week	....	56	....	....	....	10	46
4th week	....	21	....	....	....	3	18
5th week	....	16	....	....	....	7	9
6th–13th week	....	23	....	....	....	9	14
14th week and later	....	4	....	....	....	....	4
All other	....	7	....	....	....	1	6
Total	....	592	....	....	....	186	406
Grand total	....	606	....	....	....	192	414
Number of workers	....	*9,489*	....	....	....	*4,999*	*4,490*

UNCLASSIFIED.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	....	186	16	17	62	56	35
Permanent disability: Loss of—							
Both legs	....	1	....	1	....	....	....
Both feet	....	1	....	....	....	....	1
Other	....	5	....	....	3	2	....
1 arm	....	7	....	1	3	2	1
1 hand	....	17	3	....	3	7	4
1 leg	....	14	1	1	6	6	....
1 foot	....	21	....	....	6	9	6
1 eye	....	72	8	3	19	31	11
1 thumb	....	43	2	2	12	19	8
1 finger	....	265	19	33	70	108	35
2 fingers	....	37	....	....	7	18	12
3 fingers	....	11	....	....	2	7	2
4 fingers	....	7	....	....	2	2	3
Thumb and 1 finger	....	2	....	....	....	1	1
Thumb and 2 fingers	....	1	....	....	....	....	1
Thumb and 4 fingers	....	2	....	....	1	....	1
Great toe	....	16	....	....	7	9	....
Any 2 toes	....	13	2	3	5	2	1
All other	....	111	6	28	14	57	6
Total	....	646	41	72	160	280	93
Temporary disability, terminating in—							
1st week	....	14,180	1,386	1,335	4,098	4,561	2,800
2d week	....	5,329	573	574	1,661	1,604	917
3d week	....	2,503	276	267	649	808	503
4th week	....	1,552	164	153	472	479	284
5th week	....	925	93	90	259	292	191
6th–13th week	....	1,898	218	237	540	533	370
14th week and later	....	407	39	57	133	120	58
All other	....	762	....	1	133	524	104
Total	....	27,556	2,749	2,714	7,945	8,921	5,227
Grand total	....	28,388	2,806	2,803	8,167	9,257	5,356
Number of workers	....	*263,791*	*21,547*	*24,216*	*68,130*	*97,513*	*52,385*

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY.

BLAST FURNACES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	8.7	7.1	5.9	5.1	7.2	9.4	5.9
Permanent disability: Loss of—							
Both arms	......	(1)	......	.2	......	......	......
Both legs	......	.1	......	......	.2	......	.1
Both feet	(1)	......	......	......	......	......	......
Both eyes	......	.1	......	......	......	.1	.1
1 arm	.2	.2	......	......	.2	.4	.2
1 hand	.3	.1	......	.2	.1	.2	.1
1 leg	.4	.2	.3	.2	.2	.4	.1
1 foot	.2	.3	.3	......	.6	.2	.1
1 eye	1.2	1.1	.3	1.1	1.2	1.5	1.0
1 thumb	.3	.5	.6	.7	.5	1.0	1.2
1 finger	4.1	2.2	2.5	3.4	2.7	1.8	.8
2 fingers	......	.3	......	......	.2	.3	......
3 fingers	......	.1	......	......	.2	.3	......
4 fingers	......	.1	......	......	.2	......	......
Thumb and 1 finger	......	(1)	......	......	......	......	.1
Thumb and 2 fingers	......	(1)	......	......	......	......	.1
Thumb and 4 fingers	......	(1)	......	......	......	.1	......
Great toe	.3	.2	......	......	.4	.2	......
Any 2 toes	.4	.2	.6	.7	.1	.1	.1
All other	2.1	1.8	2.5	6.5	2.0	.5	.6
Total	9.7	7.5	7.1	13.0	8.8	7.2	4.7
Temporary disability, terminating in—							
1st week	299.5	177.9	163.9	178.9	201.3	177.6	154.3
2d week	126.7	76.1	58.8	84.0	85.1	84.3	58.8
3d week	61.7	37.1	29.8	44.9	42.2	40.6	25.7
4th week	31.6	21.1	14.0	25.7	25.7	23.1	13.5
5th week	22.0	16.2	12.1	21.2	19.6	15.4	11.9
6th-13th week	39.0	25.0	19.6	27.5	27.1	29.5	18.6
14th week and later	10.2	5.7	6.8	11.2	4.1	7.0	3.0
All other	13.1	2.5	......	.7	3.9	4.4	.6
Total	603.8	361.6	305.0	394.1	409.0	381.9	286.4
Grand total	622.2	376.2	318.0	412.2	425.0	398.5	297.0
Number of workers	*124,636*	*123,669*	*10,721*	*14,905*	*36,202*	*31,904*	*29,937*

BESSEMER.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	6.6	7.4	2.1	10.6	11.2	6.5	4.2
Permanent disability: Loss of—							
1 leg	.4	.5	......	.8	.6	.9	......
1 foot	.5	.3	......	.8	.6	......	......
1 eye	2.5	1.7	1.1	3.3	2.8	.9	......
1 thumb	1.5	1.1	3.2	.8	.6	......	1.4
1 finger	7.7	4.3	7.4	5.7	4.5	5.6	......
2 fingers	......	.3	......	......	.6	.9	......
Thumb and 1 finger	......	.2	......	......	......	.9	......
Great toe	.5	.8	1.1	1.6	......	1.9	......
Any two toes	.9	1.1	1.1	3.3	.6	.9	......
All other	3.2	4.2	8.4	11.5	1.7	1.9	......
Total	17.2	14.5	22.3	27.8	12.0	13.9	1.4
Temporary disability, terminating in—							
1st week	389.4	214.9	243.7	273.5	247.0	171.5	138.2
2d week	202.5	104.2	75.9	146.6	133.8	102.0	51.2
3d week	97.6	68.2	64.3	91.7	87.0	53.8	37.9
4th week	62.2	46.5	48.5	59.0	61.9	40.8	19.6
5th week	35.0	31.4	34.8	40.1	40.7	26.9	13.3
6th-13th week	72.8	55.4	48.5	70.4	75.8	44.5	29.5
14th week and later	10.7	11.3	5.3	12.3	15.6	13.0	7.7
All other	3.6	1.5	......	.8	3.9	.9	.7
Total	873.8	533.4	521.0	694.3	665.7	453.4	298.2
Grand total	897.6	555.3	545.4	732.7	688.9	473.8	303.8
Number of workers	*28,101*	*21,557*	*3,160*	*4,071*	*5,979*	*3,596*	*4,751*

1 Less than 0.05.

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Continued.

OPEN HEARTHS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	6.6	6.7	4.5	4.1	7.3	8.5	6.0
Permanent disability: Loss of—							
Both feet	(1)	(1)	......	......	.2	......	......
Both eyes	......	(1)	......	.3	......	......	......
1 arm	.2	.1	......	......	.2	.2	......
1 hand	.3	.2	.6	......	......	.2	.7
1 leg	.6	.4	......	......	.2	.5	.9
1 foot	.8	.9	......	......	1.6	1.1	.5
1 eye	.7	.8	1.1	1.0	1.2	.3	.7
1 thumb	1.3	1.1	1.1	1.0	1.1	1.3	.9
1 finger	8.0	4.4	2.8	5.5	5.3	5.2	1.8
2 fingers	......	.4	......	......	......	1.3	......
3 fingers	......	.1	......	......	......	.5	......
4 fingers	......	.1	......	......	......	.2	.2
Great toe	.7	.5	......	.7	.3	1.0	.2
Any 2 toes	.8	.9	1.7	1.4	1.1	.8	......
All other	1.7	2.2	3.9	2.8	2.3	2.5	.4
Total	15.1	12.1	11.2	12.7	13.5	14.8	6.9
Temporary disability, terminating in—							
1st week	361.7	218.4	242.9	217.9	219.2	225.5	197.3
2d week	161.2	89.5	79.3	100.1	95.7	97.8	65.5
3d week	72.9	50.4	54.7	61.5	54.7	50.9	34.2
4th week	44.9	31.5	22.9	35.9	38.4	35.3	16.3
5th week	25.1	24.1	25.7	28.7	27.2	24.0	16.1
6th-13th week	46.3	39.6	30.7	47.0	46.3	39.2	28.9
14th week and later	9.7	9.4	7.8	12.1	12.0	9.2	4.6
All other	6.1	1.8	.6	.3	1.7	3.7	.7
Total	727.9	464.7	464.6	503.4	495.2	485.6	363.7
Grand total	749.8	483.5	480.3	520.2	516.0	508.9	376.5
Number of workers	*71,293*	*72,271*	*5,969*	*9,654*	*21,457*	*20,681*	*14,510*

FOUNDRIES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	2.9	3.1	......	2.7	4.7	2.3	1.5
Permanent disability: Loss of—							
Both eyes	......	(1)	......	......	.1	......	......
1 arm	.1	.1	......	......	.1	.1	......
1 hand	.1	.2	......	......	......	.3	.5
1 leg	.2	.5	......	......	.5	.5	.5
1 foot	.4	.2	......	......	.4	.2	2.0
1 eye	1.5	1.5	......	......	1.0	1.8	.5
1 thumb	1.5	.8	......	2.7	1.0	.7	......
1 finger	7.3	4.5	0.3	5.4	3.0	5.2	4.0
2 fingers	......	.9	......	......	1.0	.8	.7
3 fingers	......	.2	......	......	.3	......	.2
Thumb and 3 fingers	......	(1)	......	......	......	......	.2
Great toe	.8	.3	......	......	.6	.2	......
Any 2 toes	.8	.6	.3	5.4	.4	.4	.7
All other	3.0	1.2	......	2.7	1.9	.7	.7
Total	15.7	10.8	.6	16.2	10.3	10.9	10.1
Temporary disability, terminating in—							
1st week	363.1	360.4	145.1	143.5	440.1	310.2	332.9
2d week	110.4	99.6	50.9	81.2	112.5	96.5	83.0
3d week	52.6	52.8	38.2	46.0	58.2	53.6	40.3
4th week	26.6	32.3	33.1	37.9	34.1	32.0	28.2
5th week	17.3	20.5	7.6	21.7	20.4	22.7	16.8
6th-13th week	29.7	31.2	25.5	56.9	31.9	31.9	25.9
14th week and later	9.0	4.3	......	5.4	5.8	3.0	4.2
All other	8.7	7.0	......	......	10.9	6.1	1.5
Total	617.4	608.1	300.4	392.6	713.9	556.0	532.7
Grand total	636.0	622.0	301.0	411.5	728.9	569.3	544.3
Number of workers	*95,917*	*80,029*	*1,309*	*1,231*	*31,805*	*32,186*	*13,498*

[1] Less than 0.05.

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY; 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Continued.

BAR MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death		3.2	1.0	4.4	3.6	5.8	0.9
Permanent disability: Loss of—							
1 arm		.5	1.0		.4		.9
1 hand		.2			.4		
1 foot		.2				1.0	
1 eye		1.1			1.8	2.9	
1 thumb		.5			.4	1.0	.9
1 finger		7.1	5.2	6.6	9.8	10.7	.9
2 fingers		.2			.4		
Great toe		.2			.4		
Any 2 toes		.6			1.3		.9
All other		1.1	1.0	5.5			.9
Total		11.7	7.2	12.1	14.9	15.6	4.4
Temporary disability, terminating in—							
1st week		402.9	351.7	438.3	509.5	369.3	239.1
2d week		131.8	88.7	169.8	158.4	122.1	94.6
3d week		68.1	52.6	88.8	83.0	60.1	42.9
4th week		36.5	43.3	61.4	34.4	34.9	16.6
5th week		21.8	18.6	28.5	24.5	18.4	16.6
6th-13th week		43.7	34.0	62.5	45.5	42.6	34.2
14th week and later		5.9	4.1	8.8	8.0	6.8	
All other		1.9	2.1		2.2	6.8	
Total		712.6	595.1	858.1	865.5	661.0	444.0
Grand total		727.5	603.3	874.6	884.0	682.4	449.2
Number of workers		*20,992*	*3,232*	*3,042*	*7,472*	*3,439*	*3,807*

HEAVY ROLLING MILLS.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	3.5	3.9	4.7	2.3	4.8	4.8	2.3
Permanent disability: Loss of—							
Both feet		.1				.2	
1 arm	.1						
1 hand	.2	.6		1.0	.5	1.2	.3
1 leg	.2	.4	.9	.7	.2		.6
1 foot	.5	.4	.5	.3	.3	.5	.6
1 eye	.8	.8	.5	1.0	1.0	1.0	.3
1 thumb	.9	1.4	.9	1.7	1.5	2.2	.6
1 finger	7.1	5.2	3.7	6.3	5.3	8.0	1.5
2 fingers		.5			.3	1.0	.9
3 fingers		.1			.3		
Thumb and 1 finger		.1			.2		
Great toe	.6	.8		1.3	1.8	.2	
Any 2 toes	1.0	.4			1.1		
All other	1.3	2.0	4.7	2.3	1.6	1.9	.9
Total	12.7	12.8	11.2	14.6	14.1	16.2	5.5
Temporary disability, terminating in—							
1st week	219.8	144.1	152.5	133.7	106.5	184.7	166.4
2d week	87.9	61.4	45.2	65.2	72.3	62.4	47.6
3d week	44.7	31.1	25.6	38.7	33.6	30.7	23.7
4th week	25.9	20.0	19.1	22.5	21.1	21.5	14.6
5th week	17.9	15.1	11.7	17.5	15.9	16.9	11.7
6th-13th week	31.9	25.8	18.7	33.1	30.2	22.9	19.6
14th week and later	8.2	7.1	4.7	6.6	9.3	7.7	4.7
All other	7.2	1.1	.5		.8	.7	3.2
Total	443.5	305.7	278.0	317.3	289.7	347.5	291.4
Grand total	459.7	322.4	293.9	334.2	308.6	368.5	299.3
Number of workers	*67,663*	*62,957*	*7,148*	*10,076*	*20,530*	*13,788*	*11,415*

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY; 1910-1914 AND 1916-1919, AND BY YEARS, 1915 TO 1919, **BY RESULT OF INJURY**—Continued.

PLATE MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	2.9	2.2	1.5	2.1	1.9	1.8	3.0
Permanent disability: Loss of—							
Both feet	.2						
1 arm	.3						
1 hand	.5	.3		.7	.5	.4	
1 leg		.1			.5		
1 foot	.6	.2			.5	.4	
1 eye	.9	.6		.7		1.1	.9
1 thumb	.6	1.0	3.2	2.1	.5	.7	.4
1 finger	9.8	3.6	8.0	3.6	4.4	3.6	2.2
2 fingers		.3			.5		.9
3 fingers		.1			.5		
Thumb and 1 finger		.1				.4	
Thumb and 4 fingers		.1					.4
Great toe	.5	.4		.7	.5	.4	.4
Any 2 toes	1.1	.4	1.5	.7	.5		.4
All other	1.7	1.0	1.5	2.1	2.4		
Total	16.1	8.4	14.4	10.7	10.8	6.8	5.6
Temporary disability, terminating in—							
1st week	235.4	157.5	83.1	124.6	187.8	184.2	150.3
2d week	104.9	64.0	41.5	71.2	78.4	59.8	63.0
3d week	52.7	32.7	20.8	27.8	35.0	39.8	30.8
4th week	30.2	24.7	24.0	28.5	26.1	28.0	19.6
5th week	17.0	16.3	9.6	22.1	16.8	16.5	15.2
6th-13th week	32.2	26.5	14.4	33.5	27.6	28.7	23.9
14th week and later	7.8	4.4		2.1	5.9	5.4	4.8
All other	1.4	2.3		.7		7.2	
Total	481.6	328.4	193.4	310.5	377.5	369.5	307.6
Grand total	500.6	339.0	209.3	323.3	390.3	378.1	316.2
Number of workers	*21,711*	*30,505*	*2,086*	*4,681*	*6,764*	*9,302*	*7,672*

PUDDLING MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	2.3	1.8			0.8	3.7	
Permanent disability: Loss of—							
1 arm	.3						
1 hand	.5						
1 eye	1.3	1.3			1.6	1.2	
1 thumb	.8	1.3			.8	2.5	
1 finger	11.2	1.3			1.6	1.2	
2 fingers		1.3			2.4		
Great toe	.3	.4			.8		
Any 2 toes	.3	.4			.8		
All other	.3						
Total	14.8	6.0			8.1	4.9	
Temporary disability, terminating in—							
1st week	229.9	222.8			238.2	218.8	153.6
2d week	90.4	86.4			92.0	83.6	65.8
3d week	37.8	46.9			53.3	46.7	13.2
4th week	20.6	24.1			20.1	30.7	21.9
5th week	16.9	17.1			17.0	16.0	21.9
6th-13th week	25.0	30.7			32.3	32.0	17.6
14th week and later	5.7	4.4			5.7	2.5	4.4
All other	11.7	13.6			3.2	24.6	30.7
Total	438.0	446.0			461.8	454.8	329.2
Grand total	455.1	453.8			470.7	463.4	329.2
Number of workers	*12,788*	*7,600*			*4,129*	*2,712*	*759*

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Continued.

ROD MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	....	2.9	....	....	4.7	5.1	1.6
Permanent disability: Loss of—							
1 arm	....	.2	....	....	....	1.0	....
1 foot	....	.7	....	....	1.3	....	1.6
1 eye	....	2.0	....	2.7	2.7	1.0	3.1
1 thumb	....	.7	....	1.3	.7	....	1.6
1 finger	....	3.6	1.6	2.7	5.4	2.1	4.7
3 fingers	....	.2	....	....	....	....	1.6
Great toe	....	.7	1.6	....	.7	1.0	....
Any 2 toes	....	.7	....	1.3	.7	1.0	....
All other	....	6.7	12.9	13.4	4.0	5.1	1.6
Total	....	15.5	16.2	21.4	15.5	11.3	14.2
Temporary disability, terminating in—							
1st week	....	172.6	181.1	151.1	239.7	133.4	93.5
2d week	....	94.2	79.2	89.6	117.1	98.5	54.5
3d week	....	35.4	37.2	38.8	36.4	42.1	17.1
4th week	....	27.3	14.5	26.7	37.7	23.6	21.8
5th week	....	12.5	17.8	9.4	13.5	16.4	3.1
6th-13th week	....	29.1	35.6	26.7	20.2	30.8	43.6
14th week and later	....	4.5	4.8	4.0	4.0	5.1	4.7
All other	....	2.9	....	....	2.0	9.2	1.6
Total	....	378.5	370.2	346.3	470.6	359.1	239.9
Grand total	....	396.9	386.4	367.7	490.8	375.5	255.7
Number of workers	....	*14,894*	*2,062*	*2,493*	*4,951*	*3,249*	*2,139*

SHEET MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	2.3	1.5	1.4	1.8	2.0	0.6	0.6
Permanent disability: Loss of—							
Both hands	(1)	(1)	....	....	1	....	....
1 arm	.2	.1	....	.1	.2	....	....
1 hand	.4	.3	.2	.3	.2	.6	.2
1 leg	.2	.1	....	.1	.1	.2	....
1 foot	.2	.3	.4	.3	.2	.4	.2
1 eye	.4	.4	....	.3	.7	.4	.4
1 thumb	.9	.5	.6	.8	.6	....	....
1 finger	5.3	2.9	3.1	6.1	2.6	1.2	.4
2 fingers	....	.2	....	....	.3	.6	.2
3 fingers	....	(1)	....	....	.1	....	....
4 fingers	....	.1	....	....	.1	....	.2
Thumb and 1 finger	....	(1)	....	....	.1	....	....
Thumb and 2 fingers	....	(1)	....	....	.1	....	....
Thumb and 3 fingers	....	(1)	....	....	.1	....	....
Great toe	.3	.1	....	.1	.1	....	....
Any 2 toes	.4	.2	.4	.3	.1	....	....
All other	.5	.5	....	....	.1	....	3.1
Total	8.8	5.7	4.7	8.4	5.8	3.3	4.7
Temporary disability, terminating in—							
1st week	273.6	151.2	171.7	133.1	179.9	94.9	137.3
2d week	121.1	92.8	109.6	105.2	103.7	35.7	87.0
3d week	41.8	43.5	48.0	48.4	48.2	20.1	43.4
4th week	22.4	21.7	21.1	25.5	24.3	9.2	22.3
5th week	12.8	12.6	14.3	14.8	14.0	6.4	10.0
6th-13th week	20.3	21.1	19.3	27.0	23.6	10.4	18.4
14th week and later	6.2	4.0	5.5	3.8	5.1	1.2	2.7
All other	1.9	1.1	....	.3	1.7	2.9	....
Total	500.1	348.0	389.5	358.0	400.6	180.8	321.6
Grand total	511.2	355.2	395.7	368.1	408.4	184.6	326.9
Number of workers	*128,423*	*121,355*	*16,266*	*24,722*	*46,040*	*17,278*	*17,049*

1 Less than 0.05.

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Continued.

TUBE MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	1.7	1.6	0.9	0.6	2.9	1.4	1.4
Permanent disability: Loss of—							
1 arm	.1	[1]					.2
1 hand	.1	.2			.3	.2	.4
1 leg	[1]						
1 foot	.1	[1]			.2		
1 eye	.4	.5	.5	.6	.3	.4	.9
1 thumb	1.5	1.0	.9	.9	1.3	.9	.7
1 finger	5.9	4.0	3.8	5.0	4.7	4.3	1.8
2 fingers		.4			.3	.7	.5
3 fingers		.1				.2	.2
Thumb and 1 finger		[1]				.2	
Thumb and 4 fingers		[1]			.2		
Great toe	.6	.2		.6	.2	.2	
Any 2 toes	.2	.4	1.4	.6	.5	.2	
All other	2.3	.4	.5		.5	.2	.7
Total	11.2	7.2	7.0	7.6	8.6	7.4	5.5
Temporary disability, terminating in—							
1st week	197.4	106.8	113.5	26.1	186.7	96.4	70.7
2d week	90.6	43.8	41.7	32.0	60.4	42.5	32.8
3d week	42.6	21.3	18.3	18.8	27.1	20.4	18.0
4th week	21.5	17.0	11.3	18.5	19.2	16.5	16.4
5th week	13.0	10.3	9.8	9.1	12.1	8.8	10.9
6th-13th week	21.8	17.7	20.6	17.3	21.2	15.5	14.8
14th week and later	4.5	3.0	5.6	2.9	2.9	2.3	3.0
All other	.6	.7			1.3	.5	.7
Total	392.0	220.6	220.8	124.8	330.8	203.1	167.2
Grand total	404.9	229.4	229.3	133.0	342.3	211.9	174.1
Number of workers	*73,338*	*71,216*	*7,109*	*11,355*	*19,819*	*18,600*	*14,433*

MISCELLANEOUS ROLLING MILLS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	2.8	1.7	1.5	2.0	1.3	1.8	2.2
Permanent disability: Loss of—							
1 arm	.3	.2		.4	.3	.1	
1 hand	.3	.2		.4	.4	.1	
1 leg	.3	.1			.1	.1	
1 foot	.4	.2				.3	.2
1 eye	1.2	.7	.8		.9	.7	.7
1 thumb	1.5	.9	1.5	.4	.5	1.1	1.2
1 finger	5.6	3.6	3.8	7.4	3.2	3.1	3.1
2 fingers		.4			.5	.5	.2
3 fingers		.1					.5
4 fingers		.1			.1	.1	
Thumb and 2 fingers		[1]			.1		
Great toe	.5	.2	.8		.1	.5	
Any 2 toes	.5	.4	.8	.4	.8	.1	
All other	1.5	1.2	3.1	1.2	.7	1.7	.7
Total	12.1	8.3	10.7	10.3	7.9	8.5	6.7
Temporary disability, terminating in—							
1st week	327.2	222.4	203.0	171.6	256.3	220.3	202.2
2d week	182.7	81.6	72.5	70.5	107.5	72.9	62.9
3d week	85.4	40.9	38.9	40.4	48.8	37.8	34.5
4th week	46.4	23.4	16.8	27.2	32.4	19.4	15.6
5th week	27.5	16.8	8.4	19.4	20.3	13.2	19.1
6th-13th week	44.5	31.6	19.8	39.6	39.4	27.2	26.1
14th week and later	7.1	5.1	3.1	10.7	5.1	4.3	4.1
All other	4.7	10.0		.8	20.7	7.2	5.5
Total	725.3	431.8	362.6	380.3	530.4	402.3	369.9
Grand total	725.5	441.8	374.8	392.6	539.6	412.6	378.8
Number of workers	*98,809*	*80,380*	*4,367*	*8,082*	*24,811*	*29,188*	*13,932*

[1] Less than 0.05.

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910–1914 AND 1915–1919, AND BY YEARS, 1915 TO 1919, **BY RESULT OF INJURY**—Continued.

FABRICATING.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	2.9	2.5	2.6	4.7	3.0	2.4	1.1
Permanent disability: Loss of—							
Both arms	.1						
Both eyes		(1)			.1		
1 arm	.1	.1				.2	
1 hand	.2	.2			.3	.2	.2
1 leg	.2	(1)				.1	
1 foot	.2	.1				.1	.2
1 eye	1.4	.7	.9	.7	.7	.8	.4
1 thumb	1 2	.8	1.7	2.0	.4	.7	1.1
1 finger	7.7	3.7	7 0	11.4	6.7	.9	1.1
2 fingers		(1)					.2
3 fingers		(1)					.2
Great toe	.5	.3		.7	.1	.2	.6
Any 2 toes	.4	.2	2.6		.3		
All other	.8	.4	.9	2.0	.7		.2
Total	12.8	6.5	13.1	16.7	9.4	3.3	4.2
Temporary disability, terminating in—							
1st week	459.5	333.7	211.3	178.7	342.0	378.1	318.2
2d week	162.7	104.3	77.7	113.1	116.3	104.8	89.0
3d week	63.9	40.8	34.0	56.2	49.2	35.4	35.0
4th week	33.8	24.7	21.0	43.5	29.1	21.5	19.3
5th week	23.4	14.9	18.3	25.4	20.2	9.0	13.8
6th-13th week	34.5	27.7	38.4	38.2	30.2	26.3	20.8
14th week and later	4.9	4.8	10.5	15.4	4.4	3.2	3.4
All other	.5	.2			.3		.6
Total	783.2	551.1	411.2	470.5	591.8	578.3	500.0
Grand total	798.9	564.1	426.9	492.0	604.2	584.0	505.3
Number of workers	*108,538*	*77,078*	*3,818*	*4,980*	*23,382*	*29,167*	*15,732*

FORGES.

Result of injury.	1910–1914	1915–1919	1915	1916	1917	1918	1919
Death	4.2	1.9			2.4	1.0	5.4
Permanent disability: Loss of—							
Both legs		.3			1.2		
1 hand		.3				.5	
1 leg		.3			1.2		
1 foot		.6				1.0	
1 eye	1.1	.9			2.4	.5	
1 thumb	1.6	.3				.5	
1 finger	3.7	3.8			8.6	2.1	2.7
2 fingers		.9			2.4	.5	
3 fingers		.3				.5	
Thumb and 2 fingers		.3			1.2		
Great toe	.5	.3			1.2		
Any 2 toes	1.1						
All other	2.1	4.7				7.8	
Total	10.1	13.2			18.3	13.5	2.7
Temporary disability, terminating in—							
1st week	245.3	288.7			436.2	249.2	208.4
2d week	165.4	95.5			165.0	76.5	56.8
3d week	76.8	41.6			66.0	34.3	29.8
4th week	33.6	32.8			59.9	27.6	5.4
5th week	14.9	18.0			34.2	13.0	10.8
6th-13th week	21.3	29.3			56.2	19.8	18.9
14th week and later	4.3	4.4			8.6	3.1	2.7
All other	14.4	2.5				4.2	
Total	576.0	512.8			826.0	427.6	332.9
Grand total	590.3	527.9			846.8	442.1	341.0
Number of workers	*6,249*	*10,368*			*2,728*	*6,408*	*1,232*

[1] Less than 0.05.

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY RESULT OF INJURY**—Continued.

WIRE DRAWING.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death		0.8	0.4	1.4	0.7	1.0	
Permanent disability: Loss of—							
1 arm		.1		.3			
1 hand		.1	.4				
1 leg		.1			.2		
1 foot		.1		.3			
1 eye		3.4	4.0	3.8	2.2	3.9	3.3
1 thumb		1.0	.8	1.7	1.0	1.0	.4
1 finger		7.6	5.9	12.6	6.6	7.6	5.3
2 fingers		.1					.4
3 fingers		.2				.3	.8
Great toe		.3	.8		.2	.3	.4
Any 2 toes		.3	.4	.3	.2	.3	
All other		7.2	13.6	17.1	4.4	2.4	1.7
Total		20.5	26.3	36.3	15.3	15.7	12.4
Temporary disability, terminating in—							
1st week		221.8	468.7	319.0	190.6	112.4	92.5
2d week		99.6	162.0	159.8	99.6	57.5	34.3
3d week		44.4	65.3	56.5	46.4	33.2	23.9
4th week		25.5	31.8	35.6	26.5	15.9	20.6
5th week		14.6	17.0	18.5	16.8	11.2	9.1
6th-13th week		24.7	25.9	24.1	24.3	22.5	28.5
14th week and later		4.9	5.9	1.7	7.5	5.7	1.7
All other		.6		.3	1.2	.5	.4
Total		436.1	776.6	615.6	412.8	258.9	211.0
Grand total		457.4	803.3	653.3	428.8	275.7	223.4
Number of workers		*51,967*	*7,859*	*9,551*	*13,727*	*12,757*	*8,073*

ELECTRICAL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	7.6	8.9		12.2	12.2	4.4	9.1
Permanent disability: Loss of—							
1 arm	.9	.3				.9	
1 hand	.5	.3					1.3
1 leg	.2	.3			.8		
1 foot	.5	.5			.8	.9	
1 eye	.9	.8			1.5	.9	
1 thumb	.5	.3			.8		
1 finger	4.9	4.4		12.2	3.0	4.4	1.3
2 fingers		.5			1.5		
4 fingers		.3			.8		
Thumb and 1 finger		.3			.8		
Thumb and 3 fingers		.3					1.3
Great toe	.2	.3			.8		
Any two toes	1.4	.3			.8		
All other	1.2	.3			.8		
Total	11.2	8.7		12.2	12.2	7.0	3.9
Temporary disability, terminating in—							
1st week	261.0	207.6		350.1	222.7	160.5	183.9
2d week	89.7	61.1		85.6	93.5	27.2	53.5
3d week	37.2	26.7		46.9	32.7	14.9	26.1
4th week	19.0	15.4		30.1	22.8	7.9	7.8
5th week	11.6	13.9		26.5	17.5	4.4	17.0
6th-13th week	26.4	22.1		34.7	30.4	10.5	22.2
14th week and later	6.0	7.2		12.2	13.7	.9	2.6
All other	1.6	.5		2.0	.8		
Total	452.5	354.5		589.2	434.1	226.3	313.1
Grand total	471.3	372.1		613.7	458.4	237.7	326.1
Number of workers	*14,421*	*12,376*		*1,636*	*4,385*	*3,801*	*2,555*

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Continued.

MECHANICAL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	3.5	3.0	1.7	1.8	4.3	2.4	3.9
Permanent disability: Loss of—							
Both legs	......	(1)	......	.2	......	......	......
1 arm	.1	.2	......	.6	.3	......	.3
1 hand	.3	.2	......	.4	.4	.1	.1
1 leg	.2	.2	......	.2	.1	.2	.1
1 foot	.2	.3	......	......	.5	.3	.1
1 eye	1.6	1.2	......	2.0	1.1	1.4	.4
1 thumb	.9	.8	1.1	.4	1.5	.6	.7
1 finger	6.1	4.2	5.6	5.7	6.7	3.0	2.5
2 fingers	......	.3	......	......	.4	.4	.3
3 fingers	......	.2	......	......	......	.4	.4
4 fingers	......	(1)	......	......	......	.1	......
Thumb and 1 finger	......	.1	......	......	.1	.1	......
Thumb and 3 fingers	......	(1)	......	......	......	.1	......
Thumb and 4 fingers	......	(1)	......	......	......	.1	......
Great toe	.4	.1	......	.2	.1	.1	.1
Any two toes	.8	.3	......	.4	.4	.3	.1
All other	2.8	2.4	8.4	6.9	1.8	1.6	.4
Total	13.4	10.5	15.0	16.9	13.4	8.9	5.6
Temporary disability, terminating in—							
1st week	318.7	192.7	181.5	226.2	256.4	140.7	209.8
2d week	137.9	67.4	64.6	84.5	109.7	41.4	59.7
3d week	56.8	29.7	26.7	39.8	45.9	18.7	27.4
4th week	31.3	20.1	12.8	29.6	31.8	12.5	17.5
5th week	18.8	13.4	6.7	22.5	23.1	7.1	10.6
6th-13th week	36.3	24.8	21.7	31.5	42.2	11.2	29.8
14th week and later	8.0	4.6	4.5	7.7	8.7	2.2	2.5
All other	2.7	1.1	.6	.6	2.3	.9	.4
Total	610.5	353.8	319.0	442.3	520.2	234.6	357.7
Grand total	627.4	367.3	335.7	461.0	538.0	245.8	367.4
Number of workers	*97,162*	*137,257*	*5,987*	*16,920*	*33,328*	*58,003*	*23,019*

POWER HOUSES.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	2.5	3.3	......	......	4.3	5.9	......
Permanent disability: Loss of—							
Both eyes	.4	......	......	......	......	......	......
1 hand	......	.3	......	......	.9	......	......
1 leg	.8	.3	......	......	.9	......	......
1 foot	......	.3	......	......	.9	......	......
1 eye	......	.6	......	4.9	......	1.0	......
1 thumb	.8	......	......	......	......	......	......
1 finger	5.8	1.8	......	4.9	.9	4.0	......
2 fingers	......	.9	......	......	1.7	1.0	......
4 fingers	......	.3	......	......	.9	......	......
Any two toes	.4	......	......	......	......	......	......
All other	.4	1.2	......	......	......	4.0	......
Total	8.6	5.7	......	9.8	6.1	9.9	......
Temporary disability, terminating in—							
1st week	116.3	61.9	......	102.9	61.7	64.4	49.7
2d week	44.5	27.9	......	49.0	34.7	21.8	23.2
3d week	26.0	11.7	......	29.4	6.9	9.9	16.6
4th week	10.3	8.7	......	39.2	4.3	9.9	6.6
5th week	7.0	6.9	......	24.5	6.1	5.0	6.6
6th-13th week	14.4	13.2	......	29.4	12.2	8.9	16.6
14th week and later	3.3	2.7	......	9.8	4.3	2.0	......
All other	2.5	.3	......	......	......	1.0	......
Total	224.3	133.3	......	284.3	130.3	122.8	119.2
Grand total	235.4	142.3	......	294.1	140.7	138.6	125.8
Number of workers	*8,083*	*10,904*	......	*680*	*3,837*	*3,366*	*3,021*

[1] Less than 0.05.

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, BY RESULT OF INJURY—Continued.

YARDS.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	6.7	5.5	......	5.1	7.6	4.7	6.0
Permanent disability: Loss of—							
Both eyes	......	.1	......	.4	......	......	......
1 arm	.2	.3	......	.8	.4	.2	......
1 hand	.1	.6	......	......	.8	.8	......
1 leg	1.0	.5	......	......	.8	.2	1.7
1 foot	.7	.7	.8	......	.6	.4	3.4
1 eye	.8	1.0	.8	1.7	1.1	.6	1.7
1 thumb	1.2	.9	.8	1.3	1.3	.4	.9
1 finger	6.3	5.5	2.6	8.5	5.5	4.1	7.7
2 fingers	......	.3	......	......	.2	.4	.9
3 fingers	......	.3	......	......	......	.6	.9
4 fingers	......	.1	......	......	.2	.2	......
Thumb and 3 fingers	......	.1	......	......	......	.2	......
Thumb and 4 fingers	......	.1	......	......	.2	......	......
Great toe	.3	.5	......	.4	.4	.6	.9
Any two toes	1.1	.8	......	.4	.6	.8	2.6
All other	3.0	4.5	7.8	10.2	4.0	2.6	......
Total	14.7	16.3	13.0	23.8	16.3	12.2	20.5
Temporary disability, terminating in—							
1st week	251.0	170.6	216.8	202.5	191.5	116.6	202.5
2d week	105.2	67.7	61.6	82.8	83.9	48.3	59.8
3d week	45.9	27.8	24.3	39.1	29.0	20.8	32.5
4th week	24.3	18.9	20.8	17.8	19.7	17.5	22.2
5th week	17.6	12.2	10.4	12.7	13.3	10.6	15.4
6th-13th week	32.7	28.7	25.2	31.8	30.3	22.4	45.3
14th week and later	6.4	6.3	2.6	7.6	7.6	4.9	7.7
All other	2.6	3.1	......	......	4.2	3.1	7.7
Total	485.7	335.3	361.7	394.3	379.7	244.2	393.0
Grand total	507.1	357.1	374.7	423.2	403.6	261.1	423.7
Number of workers	*55,932*	*47,685*	*3,843*	*7,853*	*15,732*	*16,355*	*3,902*

COKE.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	6.8	5.4	4.0	7.6	9.6	4.1	3.1
Permanent disability: Loss of—							
1 arm	1.0	.3	......	......	.6	......	.5
1 hand	.3	.3	......	......	.6	.5	......
1 leg	.8	.1	......	......	......	......	.5
1 foot	.8	......	......	......	......	......	......
1 eye	1.0	.3	2.0	1.5	......	......	......
1 thumb	.3	.3	......	......	......	......	1.0
1 finger	2.3	2.4	4.0	3.0	3.0	2.7	1.0
2 fingers	......	.3	......	......	1.2	......	......
4 fingers	......	.1	......	......	......	.5	......
Great toe	.3	.3	......	3.0	......	......	......
Any two toes	.8	.1	......	1.5	......	......	......
All other	2.5	.6	2.0	......	.6	.5	.5
Total	9.8	5.2	8.1	9.1	6.0	4.1	3.6
Temporary disability, terminating in—							
1st week	231.1	116.1	178.0	133.6	132.4	90.0	110.0
2d week	74.0	38.3	30.3	24.3	60.8	28.5	36.8
3d week	35.1	17.3	10.1	21.3	26.5	15.4	12.3
4th week	18.1	10.3	12.1	12.1	13.2	10.0	7.2
5th week	16.6	7.2	12.1	7.6	7.2	6.3	6.7
6th-13th week	28.1	13.5	10.1	16.7	15.0	11.3	14.3
14th week and later	7.8	4.0	2.0	9.1	4.8	4.1	2.0
All other	3.5	.9	4.0	3.0	1.2	......	......
Total	414.3	207.6	258.9	227.8	261.2	165.6	189.3
Grand total	430.9	218.2	271.0	244.5	276.9	173.7	195.5
Number of workers	*13,282*	*23,263*	*1,648*	*2,195*	*5,538*	*7,368*	*6,514*

TABLE 11.—FREQUENCY RATES (PER 10,000,000 HOURS' EXPOSURE) FOR SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1910-1914 AND 1915-1919, AND BY YEARS, 1915 TO 1919, **BY RESULT OF INJURY**—Concluded.

ERECTION OF STRUCTURAL STEEL.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	....	20.1	33.2	33.0	34.6	27.0	21.5
Permanent disability: Loss of—							
1 leg	....	1.3	4.2	3.3	....	2.7	....
1 foot	....	1.3	4.2	....	5.8	....	....
1 eye	....	2.2	4.2	....	8.7	2.7	....
1 thumb	....	1.8	4.2	3.3	5.8	....	....
1 finger	....	4.9	8.3	....	17.3	....	12.9
Thumb and 2 fingers	....	.4	....	....	....	2.7	....
Great toe	....	.4	4.2	....	....	....	....
All other	....	3.1	....	3.3	5.8	....	17.2
Total	....	15.6	29.1	9.9	43.3	8.1	30.1
Temporary disability, terminating in—							
1st week	....	371.8	589.5	366.0	689.2	602.4	511.6
2d week	....	101.2	157.7	148.4	201.8	127.0	116.1
3d week	....	56.6	103.8	72.6	124.0	62.1	60.2
4th week	....	35.7	87.2	62.6	46.1	37.8	43.0
5th week	....	24.5	24.9	56.1	37.5	27.0	38.7
6th-13th week	....	62.9	74.7	79.1	126.8	110.8	60.2
14th week and later	....	18.7	4.2	42.9	49.0	16.2	21.5
All other	....	1.8	....	....	....	....	17.2
Total	....	673.2	1,041.9	827.6	1,274.5	983.3	868.4
Grand total	....	708.8	1,104.2	870.4	1,352.4	1,018.4	920.0
Number of workers	....	*7,477*	*803*	*1,011*	*1,156*	*1,234*	*775*

UNCLASSIFIED.

Result of injury.	1910-1914	1915-1919	1915	1916	1917	1918	1919
Death	....	2.4	2.5	2.3	3.0	1.9	2.2
Permanent disability: Loss of—							
Both legs	....	(1)	....	.1	....	....	....
Both feet	....	(1)	....	....	....	....	.1
1 arm	....	.1	....	.1	.1	.1	.1
1 hand	....	.2	.5	....	.1	.2	.3
1 leg	....	.2	.2	.1	.3	.2	....
1 foot	....	.3	....	....	.3	.3	.4
1 eye	....	.9	1.2	.4	.9	1.1	.7
1 thumb	....	.5	.3	.3	.6	.6	.5
1 finger	....	3.3	2.9	4.5	3.4	3.7	2.2
2 fingers	....	.5	....	....	.3	.6	.8
3 fingers	....	.1	....	....	.1	.2	.1
4 fingers	....	.1	....	....	.1	.1	.2
Thumb and 1 finger	....	(1)	....	....	....	(1)	.1
Thumb and 2 fingers	....	(1)	....	....	....	....	.1
Thumb and 4 fingers	....	(1)	....	....	(1)	....	.1
Great toe	....	.2	....	....	.3	.3	....
Any two toes	....	.2	.3	.4	.2	.1	.1
All other	....	1.5	.9	3.9	.8	2.0	.4
Total	....	8.2	6.3	9.9	7.8	9.6	5.9
Temporary disability, terminating in—							
1st week	....	179.2	214.4	183.8	200.5	155.9	178.2
2d week	....	67.3	88.6	79.0	81.3	54.8	58.4
3d week	....	31.6	42.7	36.8	31.8	27.6	32.0
4th week	....	19.6	25.4	21.1	23.1	16.4	18.1
5th week	....	11.7	14.4	12.4	12.7	10.0	12.2
6th-13th week	....	24.0	33.7	32.7	26.4	18.2	23.5
14th week and later	....	5.1	6.0	7.8	6.5	4.1	3.7
All other	....	9.6	....	.1	6.5	17.9	6.6
Total	....	348.1	425.3	373.6	388.7	305 0	332.7
Grand total	....	358.7	434.1	385.8	399.6	316.4	340.8
Number of workers	....	*263,791*	*21,547*	*24,216*	*68,130*	*97,513*	*52,385*

[1] Less than 0.05.

TABLE 12.—NUMBER OF CASES OF ACCIDENT, AND AVERAGE TIME LOSS PER CASE, IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY OCCUPATIONS.

Department and occupation.	Number of cases.	Average severity per case (days).
Blast furnaces.		
Blacksmiths	21	579.8
Blowers	24	767.1
Boiler makers	74	97.8
Brakemen	23	1,129.1
Bricklayers	16	498.9
Carpenters	18	189.7
Cinder snappers	112	135.8
Crane hookers	17	28.6
Cranemen	18	341.7
Engineers	20	29.2
Firemen	31	74.7
Foremen	39	166.4
Handy men	19	15.7
Inspectors	14	439.1
Keepers	229	76.7
Laborers	740	249.8
Ladle liners	12	22.9
Ladle men	32	90.3
Larry men	65	110.6
Machinists	53	163.8
Millwrights	20	17.1
Molders	10	26.3
Oilers	49	223.7
Pig-machine men	11	558.9
Pipe fitters	40	205.1
Repair men	26	167.9
Riggers	96	266.4
Stockers	18	235.6
Stove cleaners	17	358.7
Stove tenders	36	176.6
Switchmen	27	462.7
Water tenders	13	12.3
Unclassified	188	169.9
Total	2,128	211.8
Bessemer.		
Brakemen	17	415.4
Crane hookers	11	1,135.6
Foremen	12	42.3
Laborers	229	139.8
Ladle men	25	504.9
Mold cappers	11	595.2
Pit men	10	23.3
Riggers	14	52.4
Steel pourers	19	16.9
Stockers	19	124.8
Switchmen	20	86.9
Vessel men	21	49.0
Unclassified	154	220.2
Total	562	198.6
Open hearths.		
Blacksmiths	16	17.1
Brakemen	21	91.2
Bricklayers	29	221.7
Charging-car operators	20	19.0
Chippers	13	14.5
Cinder snappers	44	288.8
Crane hookers	73	105.6
Cranemen	79	188.3
Door operators	43	17.5
Firemen	48	13.3
Foremen	57	186.8
Gas makers	30	14.3
Handy men	11	11.2
Inspectors	23	536.3
Laborers	1,080	127.6
Ladle liners	12	510.8
Ladle men	72	157.2
Machinsts	27	13.7
Melters	588	70.7
Millwrights	39	327.3
Mixer men	30	10.9
Open hearths—Concluded.		
Pipe fitters	12	17.8
Pit men	295	37.7
Repair men	10	23.8
Riggers	12	102.9
Scrap men	18	16.3
Shear men	12	43.3
Steel pourers	179	26.1
Stockers	193	110.4
Stopper setters	20	31.9
Switchmen	74	184.9
Unclassified	182	281.3
Total	3,362	114.6
Foundries.		
Chippers	270	21.0
Core makers	60	11.5
Crane hookers	181	115.1
Cranemen	23	279.6
Foremen	28	21.5
Grinders	62	11.2
Inspectors	10	20.0
Laborers	384	36.2
Ladle men	11	11.4
Machinists	22	13.9
Melters	24	41.4
Molders	251	74.1
Rammers	30	117.1
Roughers	11	566.0
Sand blasters	30	23.3
Stockers	14	19.9
Watchmen	16	15.6
Unclassified	222	114.6
Total	1,649	63.9
Heavy rolling mills.		
Bottom makers	52	14.6
Chippers	206	114.8
Cinder men	11	40.7
Crane hookers	59	42.4
Cranemen	76	91.9
Engineers	35	215.7
Foremen	28	19.2
Guide setters	16	6.3
Handy men	15	486.7
Heaters	44	161.2
Hot-bed men	42	74.3
Inspectors	37	36.5
Laborers	802	99.4
Liner men	34	201.3
Loaders	41	38.9
Machinists	74	227.1
Millwrights	80	174.7
Oilers	71	276.9
Pilers	24	22.0
Pipe fitters	11	52.8
Riggers	41	111.7
Rollers	36	86.4
Roll hands	27	75.5
Saw men	27	18.1
Scale men	25	261.1
Scrap men	24	15.3
Shear men	53	31.5
Stampers	20	23.2
Stockers	36	20.9
Straighteners	32	21.3
Switchmen	10	42.8
Tablemen	22	9.9
Tong men	14	29.4
Burners	14	49.2
Unclassified	251	96.0
Total	2,390	103.6

TABLE 12.—NUMBER OF CASES OF ACCIDENT, AND AVERAGE TIME LOSS PER CASE, IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY OCCUPATIONS—Continued.

Department and occupation.	Number of cases.	Average severity per case (days).
Plate mills.		
Chippers	11	18.2
Crane hookers	55	33.5
Cranemen	25	254.1
Firemen	12	12.3
Foremen	37	36.4
Handy men	15	8.1
Heaters	20	315.0
Inspectors	24	12.3
Laborers	831	54.8
Layers out	30	11.4
Loaders	18	365.0
Millwrights	16	10.7
Machinists	18	62.0
Oilers	27	29.1
Painters	13	15.7
Pilers	22	20.7
Rollers	12	7.5
Scrap men	139	14.1
Shear men	354	45.5
Stampers	14	11.1
Unclassified	192	84.3
Total	1,885	56.4
Tube mills.		
Bellers	12	24.7
Crane hookers	26	66.2
Laborers	198	60.5
Loaders	19	1,097.2
Machinists	14	44.4
Machine hands	17	80.2
Pipe cutters	71	31.5
Pipe testers	19	19.1
Pushers	10	37.5
Tappers	10	26.3
Welders	18	24.1
Unclassified	208	237.1
Total	622	144.4
Sheet rolling mills.		
Catchers	72	30.2
Doublers	63	13.6
Heaters	100	45.0
Laborers	38	46.8
Matchers	58	15.5
Millwrights	12	67.6
Openers	84	16.4
Rollers	73	17.3
Roughers	33	14.4
Scrap men	15	7.7
Shearmen	98	55.9
Unclassified	69	22.8
Total	715	29.8
Fabricating.		
Benders	23	52.1
Bending-machine operators	13	23.6
Blacksmiths	11	105.4
Bolters	130	118.3
Buck-ups	56	20.1
Carpenters	15	12.4
Chippers	22	44.4
Crane hookers	51	158.1
Drillers	19	341.3
Fitters	70	115.8
Foremen	31	32.1
Laborers	279	62.0
Layers-out	18	9.7
Machinists	117	22.4
Fabricating—Concluded.		
Machine hands	17	11.6
Painters	21	21.6
Pattern makers	20	13.4
Punchers	138	53.5
Reamers	136	26.3
Repair men	40	11.6
Riggers	17	9.4
Riveters	50	13.9
Shearmen	58	12.4
Stick-ins	36	14.3
Rivet heaters	19	329.5
Unclassified	177	97.0
Total	1,584	64.4
Electrical.		
Charging-car operators	16	6.8
Cranemen	128	65.2
Electricians	79	129.2
Inspectors	68	257.1
Laborers	11	9.4
Linemen	31	789.7
Machinists	24	40.3
Millwrights	10	647.6
Repair men	40	175.3
Wiremen	16	380.4
Unclassified	66	211.9
Total	489	194.8
Mechanical.		
Blacksmiths	183	26.0
Boiler makers	325	77.7
Bricklayers	200	83.1
Carpenters	124	74.1
Crane hookers	36	30.1
Cranemen	18	339.2
Drillers	49	28.5
Electricians	10	606.1
Engineers	14	38.3
Foremen	36	251.2
Grinders	10	22.3
Hammer men	16	31.3
Handy men	43	22.0
Laborers	284	45.2
Machinists	815	55.2
Machine hands	84	35.5
Millwrights	120	126.3
Oilers	22	50.7
Painters	28	447.6
Pattern makers	26	49.7
Pipe fitters	144	97.0
Repair men	42	61.6
Riggers	280	92.2
Riveters	76	19.5
Burners	10	31.5
Rivet heaters	20	109.5
Structural-iron workers	12	516.9
Unclassified	164	158.2
Total	3,191	78.8
Yards.		
Brakemen	92	391.0
Crane hookers	39	181.8
Cranemen	17	727.4
Engineers	84	150.8
Firemen	48	280.6
Foremen	12	528.1
Laborers	476	130.4

TABLE 12.—NUMBER OF CASES OF ACCIDENT, AND AVERAGE TIME LOSS PER CASE, IN SPECIFIED DEPARTMENTS IN THE IRON AND STEEL INDUSTRY, 1915 TO 1919, BY OCCUPATIONS—Continued.

Department and occupation.	Number of cases.	Average severity per case (days).	Department and occupation.	Number of cases.	Average severity per case (days).
Yards—Concluded.			*Unclassified*—Concluded.		
Oilers	10	611.4	Lever men	13	11.0
Repair men	23	23.6	Loaders	84	90.7
Switchmen	414	183.0	Machinists	294	94.7
Unclassified	86	254.9	Machine hands	291	23.6
			Matchers	24	9.9
Total	1,301	197.0	Melters	22	21.1
			Millwrights	98	170.0
Unclassified.			Molders	29	23.1
			Oilers	60	206.2
Axle cutters	27	14.0	Openers	17	12.4
Axle makers	54	13.2	Painters	36	179.9
Axle turners	34	10.0	Oilers	38	15.3
Blacksmiths	47	279.5	Pipe fitters	26	19.5
Boiler cleaners	22	290.8	Press hands	17	37.9
Boiler makers	18	13.2	Puddlers	43	16.7
Brakemen	17	375.5	Punchers	31	31.5
Bricklayers	36	15.5	Repair men	54	133.6
Bundlers	53	17.6	Riggers	77	120.7
Carpenters	41	16.5	Riveters	21	27.2
Catchers	50	16.7	Rollers	88	20.5
Chargers	62	212.0	Roll hands	76	14.5
Chippers	197	71.3	Roughers	65	52.8
Crane hookers	260	103.3	Saw men	34	194.5
Cranemen	87	158.9	Scrap men	28	78.5
Doublers	16	12.5	Shearmen	197	31.9
Drillers	28	234.6	Stampers	18	7.9
Electricians	27	22.9	Stockers	72	15.2
Engineers	45	159.2	Straighteners	46	15.4
Feeders	14	194.1	Stranders	32	11.6
Finishers	12	17.0	Switchmen	29	152.0
Firemen	97	339.5	Tong men	21	298.2
Foremen	111	237.4	Truckers	41	12.5
Gas makers	18	16.7	Water tenders	17	19.2
Grinders	29	21.9	Wire drawers	94	44.4
Hammer men	92	35.3	Burners	11	560.5
Handy men	23	21.1	Wheel rollers	73	30.8
Heaters	125	21.0	Wheel turners	29	28.2
Hot-bed men	34	16.2	Forging operators	37	20.1
Inspectors	50	85.9	Unclassified	750	130.6
Laborers	2,388	93.7			
Ladle men	14	34.0	Total	7,172	92.03
Layers-out	11	9.0			

INDEX.

A.

B.

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
60 CENTS PER COPY
▽