INDUSTRIAL MEDICINE

BY

CARL THERON CLAUSON

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Industrial medicine is a branch in which the medical, economic and sociologic aspects are very closely interwoven. Industry has adopted the physician not from altruism, but because preventive medicine is sound business.

HISTORICAL DEVELOPMENT

The health of workers in industry received up to nineteen years ago surprisingly scant attention. Apparently neither employer nor state recognized the enormous economic factor entailed. Except in a few isolated instances little or no thought was given to what is today becoming one of the most important factors in econpmics. One reason was the rapid expansion of business with the almost limitless amount of labor pouring in yearly from Europe. Moreover the wastage of "hiring and firing" was not recognized, a large labor turnover being considered a normal and unavoidable condition. In many factories and especially in mining camps a full time doctor was employed, but this function was almost entirely to care for accidents. The work was considered unscientific and not particularly desirable. The passage of workmen's compensation act by the state after state, however, has induced employers because of their financial obligations to consider the safety of the workers more carefully than formerly and in case of accidents to provide the most effective treatment possible.

In 1909 public sentiment and activity were, for the first time, aroused vigorously to combat tuberculosis. A wave of publicity swept the country stimulating thought and effort toward prevention and cure. One

of the most active participants in the movement was the "Committee on Factories" of the Chicago Tuberculosis Institute, composed of Drs. James Brittob, Theodore Sachs, and Henry Faville. These men introduced the idea of physical examinations of workers in factories. Prior to the year 1906, Dr. Frank T. Fulton had examined a number of workers in one of the parge saw factories of Providence, Rhode Island, in an effort to isolate tuberculous workmen. At almost the same time numerous industries in different parts of the country began examining their employees to advise them in caring for conditions found at such examinations. A number of doctors, having little knowledge of similar work done elsewhere, all saw the need at practically the same time. By their work they were able to convince the industry that the physical examination of employees from the highest executive down, was an economically sound policy. When any factor brings about an economical gain industry is ready to accept it. I wish to emphasize that industry accepted industrial medicine not from an altruistic standpoint but from an economic standpoint.

The American Association of Industrial Physicians and Surgeons was organized by one hundred twenty five industrial physicians in 1916, at Detroit. The importance of industrial medicine in the eyes of the government at Washington is evidenced by the establishment in 1912 of the Division of Industrial Medicine and Hygiene in the United States Public Health Service.

Thus has gradually developed a new specialty in the medical profession - Industrial Medicine and Surgery. This specialty is now becoming so well organized that several medical schools are instituting full courses in this subject.

The economic aspect of a medical department is well worth considering, Such a medical department is an asset financially to a company rather than a liability. The presence of a well organized medical department not only reduces the frequency of accidents, but also tends to reduce their seriousness. This in many instances directly influences the insurance rate charged against an industrial plant. If a plant has its own insurance department a great amount is saved. It also, by giving first aid treatment in case of accidents and also by the early detection of any condition due to industrial causes, such as pneumoconiosis, poisoning of various sorts, etc., has saved a company many thousands of dollars a year by preventing conditions which leads to compensation or law suits. In prevention of these two conditions companies have saved many thousands of dollars per year. Medical service tends to lessen labor tunover through the selection of men for jobs for which they are physically fit, the care of the injured, supervision of the health of employees. It also prevents the established employees from giving up their occupations. Medical service has a direct bearing on the amount of time lost by employees due to sickness, especially preventable sickness from industrial hazards. The beginning of many serious illnesses may be prevented by the recognition and treatment of minor injuries and diseases.

Medical service has a direct bearing on output. A sick or absent employee reduces the output of the machine which he is attending. To obtain correct data in dollars and cents as to what a medical department will save an industry is impossible as the work done by preventing sickness cannot easily by put on such a basis. A department endeavors to detect potential sickness before it has become serious, curing the sickness as soon as possibly thereby keeping the man working. It would be difficult to determine just what the sickness would lead to and the loss of time which would result.

The following data with one's knowledge of medicine will enable one to make some estimate of the saving and also some estimate as to prevalence of certain conditions excluding accidents. The following figures are the average number of medical cases per month for the year 1927 at the Bucyrus Company, South Milwaukee. This company manufactures iron and steel machinery.

Cold treatment	203
Sore throat	76
Headache	67
Sore eyes	103
Earache	19
Surgical Dressings	234
Stmach Disorders	39
Cathartics	38
Requests for liniments	11
Colds where fevers were present	28
Boil treatments	69
Toothache	6
Tonics	3.5
Rheumatism medicine	59
X-Ray pictures	128
Requests for plasters	9
Simple rashes	8
Hiccough	0.33
Pleurisy	2.25

Pink eye	3.60
Nose bleed	0.25
Catarrhal vaccine hypo for colds	.17
Cold sore treatment	9
Cancer sore	4.60
Special Hypo given	1.60
Mumps	.66
Eczema	3.0
Poison ivy	2
Hypo for hay fever	2
Neuralgia	2
Sun burn	.60
Home burns dressed	2
Frost bites	.17
Violet Ray	.75
Alpine lamp treatment	.96
Therapy lamp treatment	.88
Miscellaneous	.122

The cost of medical service in industry has been summed up in a survey, the most recent being that of the Natiocal Industrial Conference Board in 1923-24, covering 447 establishments employing 1,031,279 workers. The average cost of the medical service per employee per year was found to be $5.14. A survey in 1915 showed a medical service cost of $4.88 and in 1919 it was $4.43. The average cost in individual industries ranged from $1.84 in the tobacco industry to $24.40 in the mining industry. The cost per employee varies directly with the size of the plant. Plants having less than:

500 employees	$7.53
500 to 999 employees	$6.02
1000 to 1,999 employees	$6.36
2,000 to 4,999 employees	$5.30
5,000 to 9,999 employees	$4.53
10,000 and over	$4.30

As regards the elements of cost the major item is that of the salaries of physicians and nurses, which was 57.1% of the total reported expenses, 8.4% for salaries of assistants, 18.5% for outside expenses representing fees to specialists, hospital expenses, etc. and 10.5% for supplies.

The organizations differ slightly in the various companies depending on their size and type of industry. Some small companies may employ only one or two men while the larger companies have a distinct organization based somewhat according to the following charts. In some organizations the medical deparment is responsible directly to the management; in others it is included in the personnel department.

The functions of a health department are as follows:

1: Physical examination of applicants.

2: Physical examination of employees.

3: Periodic re-examination of defectives.

4: Periodic re-examination of employees exposed to industrial hazards.

5: Advise employment department on placement of defectives.

6: Treatment of medical cases

7: Treatment of surgical and accident cases.

8: Treatment of ocular cases.

9: Treatment of dental cases.

10: Prevention of communicable diseases.

11: Cooperation with employment department and safety department in investigating absences.

12: Furnishing employment with data concerning employees who are leaving on account of ill health.

13: To keep adequate examination and treatment records.

14: Furnish statistics pertaining to health.

Figure I visualizes the organization of a medical department which is responsible directly to the management of a company. This shcematic chart illustrates the organization of a department in the larger industries. Figure II illustrates the organization in a factory of about 3,000 employees. A small factor employing about 500 men or less may not have a full time physician but may employ a part-time physician.

Factory accidents vary from the most severe to the trivial. It is the latter class which predominates. Figure III illustrates the procedure used by an employee who is injured while at work. This procedure is essentially the same in any factory. The Safety Department may need explanation. This department attempts to learn the manner in which the accident occurs so that steps may be taken to prevent a similar accident in the future, such as placing guards on some uncovered portion of a machine previously considered safe. Figure IV illustrates the course taken by an employee who has been severely injured.

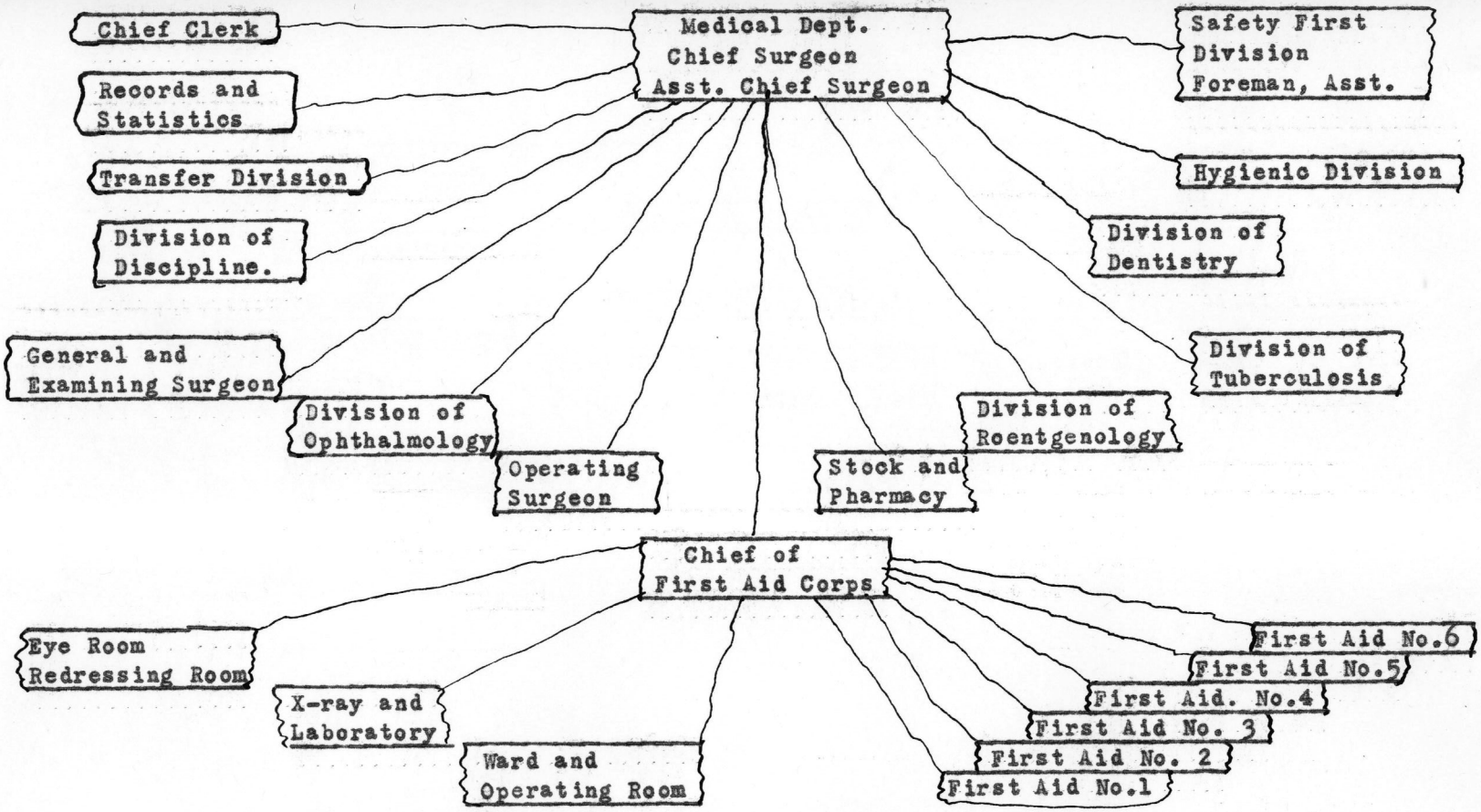


FIGURE NO. I

Organization of a Medical Department responsible directly to the Management.

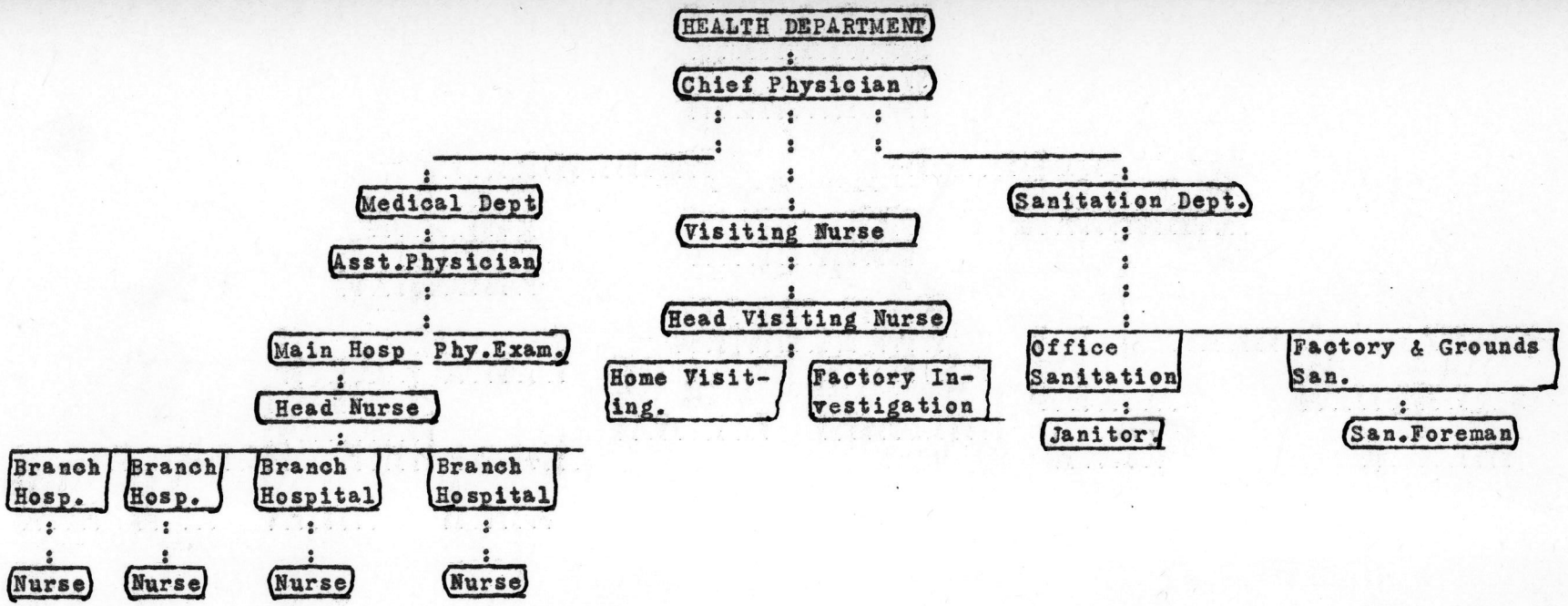
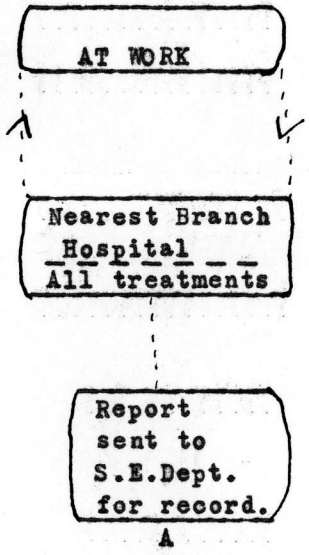


FIGURE II

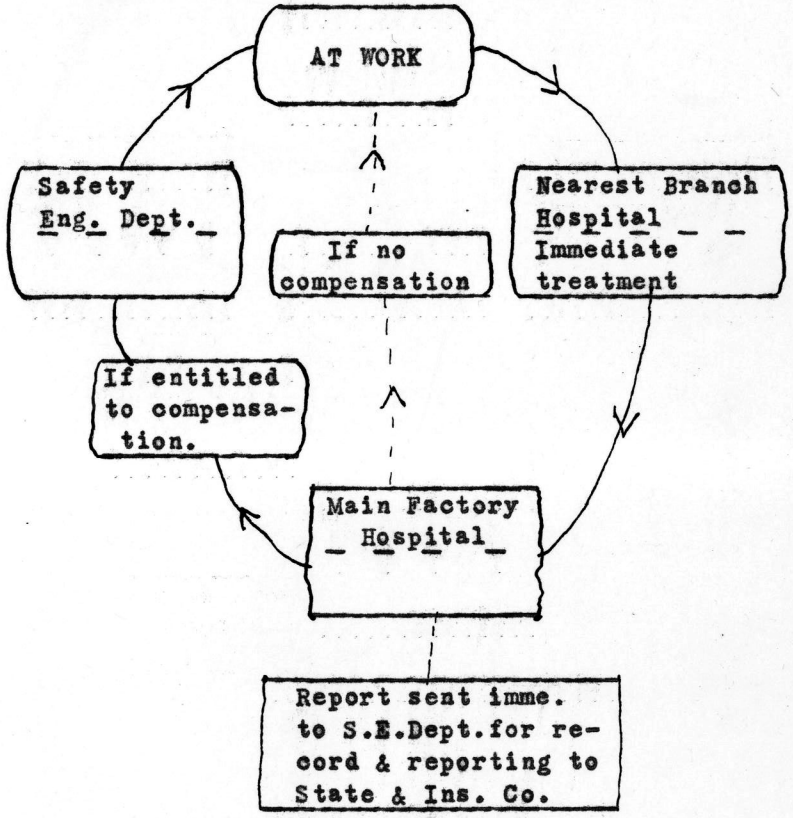
Chart of organization of a Health Department in a Factory of about 3,000 employees.

SLIGHT INJURIES



A

INJURIES OF MEDIUM SEVERITY



B

FIGURE III

A - Accident cycle in slight injuries showing course of injured workman to and from Branch Hospitals.

B - Accident cycle in injuries of medium severity showing course of injured workman and points of contact with Health and Safety Departments. In this case the workman is supposed to be in condition to report to Main Hospital for treatment.

SEVERE INJURIES

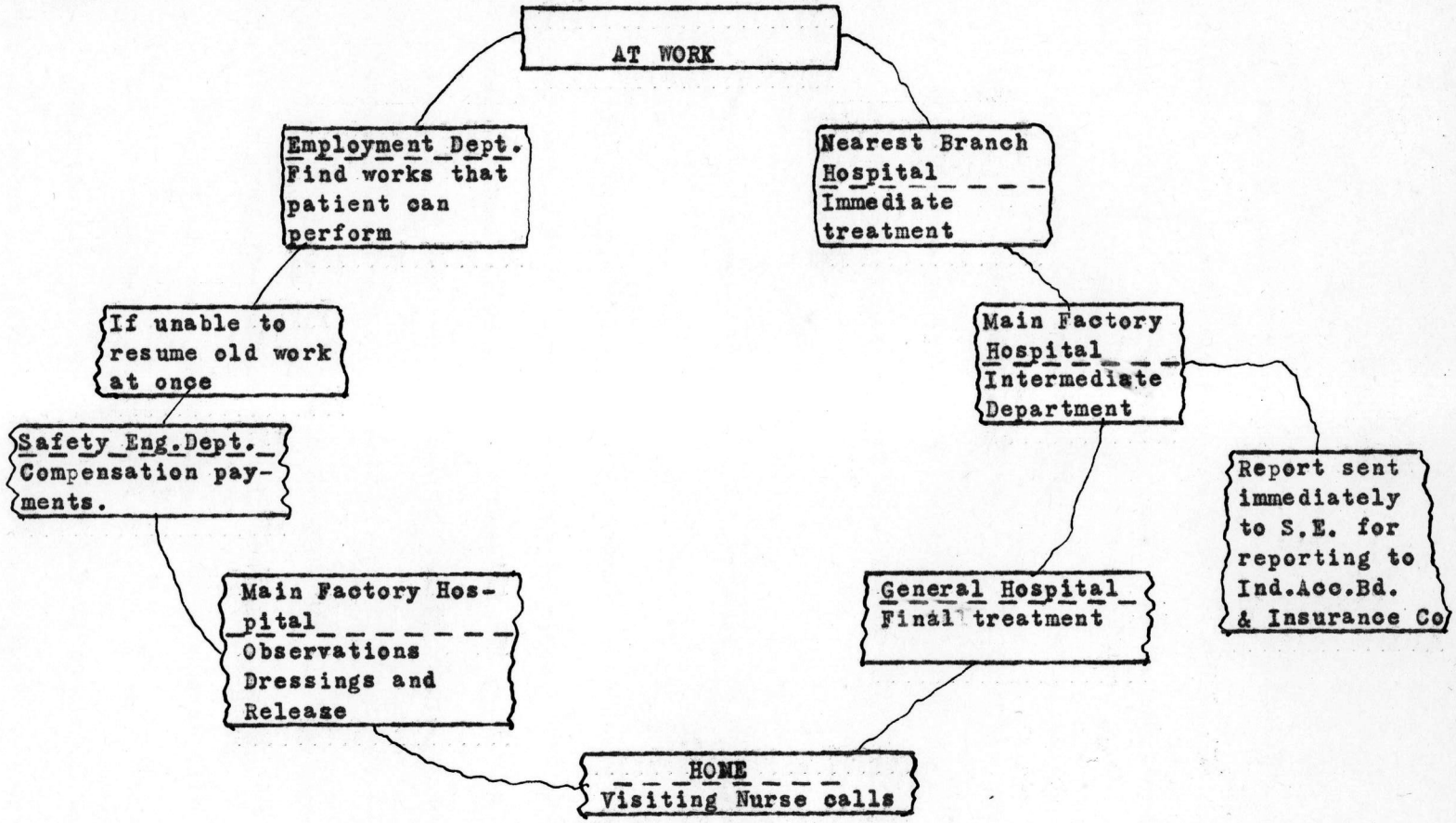


FIGURE IV

Accident cycle in severe injuries showing course of injured workman and points of contact with Health. Safety, Visiting Nurse and Employment Department.

In the remaining portion of this paper procedures used to prevent accidents and industrial diseases will be explained. The nature of the disease, diagnosis, and treatment, will not be discussed.

The prevention of accidents will be discussed first. It was due to casualties that legal procedures were first directed against industry. Injuries caused by accidents forms the highest percentage of cases treated in any industrial medical department. Accidents are many in the heavier industries.

The Safety Engineering Department attempts to cover all exposed movable parts. Not only those parts seen by the eye, but any movable part which may come in contact with loose articles of clothing. Mechanical devices are made to feed material into dangerous areas on machines. These devices alleviate the necessity for operators to place material directly under punches, presses or between rollers, etc. Nonbreakable glass goggles are worn on jobs where particles may be hurled into the eyes of the operator. At the Pulmman Car Works goggles are issued to all men where protection of the eyes is indicated. They use several types of goggles, some are 46 mm. round, are made like spectacles and protect the eyes and upper cheek. Some have no sides screens while other have. The side screens keep dust and particles coming in around the back of the lenses and envelop the eye with a metal screen aroundall sides. For sand blaster a finer mesh is used on the side screens. In extremely dusty places rubberoid goggles are used which protect the eye better than the screen type. For arc welders colored lenses are used.

which do not allow penetration of the ultra-violet rays. The lens material is of such type that when a blow is heavy enough to break the lens the same only shatters, does not leave the frame, and does not chip or give off glass particles which could become lodged in the eye. Employees are instructed not to lend their goggles to each other thereby preventing the spread of infectious diseases. Men operating overhanging cranes must have 20/20 vision lens. These men may be over steam one minute and cold air another, so it is not practicable for them to wear lens because they are apt to become steamy thereby impairing their vision and endangering themselves or men below. These men do not have to wear goggles because they are far too high for danger to themselves.

Drive shafts and belts are a great source of danger. Loose articles of clothing are easily caught by belts and many an employee has been seriously injured or killed in this manner. Heavy belts driven at high speed or breaking have caused the death of many an employee. All modern plants are supplanting belt drives wherever possible by direct drives with a motor attached to the machine.

There is a movement in Wisconsin to have the industrial insurance rate directly proportional to the number and efficiency of preventive devices installed in a plant. It is also based on the number of accidents in that plant. This will be an incentive to stimulate the management to install efficient preventive measures against accidents.

A very excellent and simple method to prevent burns on legs and feet of molten iron carriers consists of a closely woven canvas legging and a specially constructed shoe. This canvas legging is fastened to the outside of the shoe and prevents molten iron from running down the leg and into the shoe. The shoe used is the one piece type without tongue and lace, thereby preventing any molten iron from settling down between lace and lodging in the shoe.

Any employee injured no matter how trivial is compelled in many companies to attend the first aid station. The basis for this rule is that any accident or laceration even though very slight is a potential danger unless it receives early and proper treatment. The standard form of treatment for open wounds as outlined by the Conference Board is as follows: Benzene or gasoline is employed as a cleaning agent to remove grease before any antiseptic is applied. Iodine is then used. The International Harvester Company of Chicago does not use iodine but they use a 2% mercurochrome solution which is applied directly to the wound, The first layer of bandage immediately in contact with the wound and surrounding area is saturated with mercurochrome. This forms a protective layer and the sterile bandage is completed over the saturated portion.

Safety campaigns are promoted at various times throughout the year to keep the spirit of prevention before the minds of all employees. Bulletins and notices are posted in conspicuous places in the various plants in the attempt to promote safety. The Interstate Iron and Steel Company of Chicago report a 15% decrease in accidents since safety notices

and campaigns were instituted and their compensation costs were reduced 30%. In addition to bulletins and notices the International Harvester Company has a safety flag at the entrance to various departments. This flag is lowered if any employee receives an injury which is severe enough to cause him to discontinue work for two days or more. The employees watch this flag every day and take great pride in keeping the flag for their department flying.

There are many rules used in the attempt to prevent accidents and these vary depending on the type of plant. Most plants employing overhead cranes prevent their workmen from taking positions directly underneath the crane and especially if it is carrying any type of lead that may accidently drop.

It might be well to mention methods used to prevent explosions caused from dust in flour mills. When these explosions occur they cause many injuries and burns as well as many deaths. Dust in flour and feed mills is always a potential source of danger and especially mills engaged in the grinding of corn. Corn dust is particularly fine and the finer the dust the more is the danger. Employees take very precaution known to prevent these explosions. Now employees are always warned as to the methods which are at present known to give rise to the explosion. Therefore, if any of these known methods are seen they are eradicated at once. The lighting of matches in dusty rooms is strictly prohibited. The United

States Department of Industrial Hygiene has found through experimentation that under certain conditions of temperature and humidity it is just as dangerous to light a match in dusty rooms in flour mills as it is to light a match in a room heavily laden with gasoline fumes. Electric motors are enclosed in chambers to that there is no possibility of an open spark. In chambers where open sparks cannot be avoided means are taken to reduce the oxygen supply to a low level which will prohibit explosion. It has been found through experiments that spark first ignites the dust suspended in the air, this in turn secondarily ignites dust which has settled on floors, machines, or beams, and it is the secondary explosion which is the severe one, causing crumbling of walls and fire. The deeper the layer of dust the greater the hazard. Therefore, all surfaces are kept free of settled dust. This in turn is prevented by constructing all machines with exhaust ventilation or enclosed so that no dust can get into the air. Continual cleaning of settled dust is also a routine.

The electrical industry use many protective devices against burns and injuries. Precautions are taken with thoughtfulness to protect workmen from dangerous contact with live electric conductors. Some of these follow: Rubber gloves are used for work on circuits of dangerous voltage and employees are required to wear them whenever there is a possibility of making a high voltage contact. Gloves are often initially tested to withstand 18,000 volts and are discarded when they show imperfections or deterioration. Tools fitted with insulated handles or otherwise specially arranged are provided further to protect the workmen

against accident. For men working upon outside lines protectors or blankets, and other rubber appliances are provides for covering live wires adjacent to those upon which the work is being done. Circuit breakers in electric stations have grown so large in voltage that it is not safe to touch or be near the switch. These switches are now operated by small motors or some electromagnetic appliances which in turn are operated by small hand switches on a control switchboard

As a proof that preventative measures are achieving results is brought out in the reports of the Industrial Commission of Wisconsin. The Commission reports a decrease of 5% in industrial accidents for the first 11 months of 1927 as compared to the first 11 months of 1926. A total of 22,930 was reported last year, while the figure of the previous year was 23,995 (this represents a decrease of 5%). For the first 11 months of 1927 the Commission closed its files in 18,988 cases for compensation benefits amounting to $4,406.584 as compared with 20,376 cases for compensation benefits of $4,499,177 for the corresponding period one year before. The average indemnity benefit per case settled amounted to $166 in 1925, $167 in 1926, and $177 in 1927. Medical benefits per case amounted to $52 in 1925, $53 in 1926, and $55 in 1927. The amount of indemnity paid per case has increased consequent upon legislative increases in indemnity allowance, therefore, it is of an economic standpoint for any concern to install accident preventive devices.

The productive capacity of manufacturing industries is in part a funetion of thephysical, physiological, psychological condition of the

employees. This important fact has attracted more attention in the past ten years than in any previous time. The rationality and economy of long time physiological efficiency is gradually coming to be appreciated. Many efforts have been made in this country and England to study the problem of fatigue in industry. Everyone knows that a certain degree of fatigue is the result of normal body activity and is harmless. It is not so generally recognized that the onset of exhaustion is greatly hastened after normal fatigue is reached. Deleterious effects on both the worker and the plant may be caused by conditions of work inside the factory or by the occupation, habits, and living conditions of the worker outside the factory or both. No general rule can be laid down for the hours of active work which may vary with the character of employment. A tired brain, tired nerves, and tired muscles are a menace to a workman himself as well as to others. Accidents are especially prone to happen to workmen under of these conditions. The number of accidents increase progressively during the morning hours, drops after the noon intermission and then rises from hour to hour until the end of the working day. Fatigue is not only dangerous to himself but sometimes to others, thus an over tired train dispatcher may send trains into a collision.

To alleviate some of the strains and conditions causing fatigue some factoires have installed chairs with foot rests for employees who can carry on their work just as efficiently when seated. This in turn tends towards prevention of various varicose veins and flat feet. Rest periods have come into the minds of managers especially since the Munition

Workers Committee made their report in 1918. It has been proven that rest periods greatly increase efficiency and production. Heavy work usually requires a longer rest period than does light work. This Board reported a case from a hosiery factory - after short rest periods were introducted the factories production increased. The Commission made a survey and found that in 388 representative American industries 67 manufacturing establishments employing 95,653 men and 40,930 women, 15% of the men and 63% of the women were given rest periods varying from a single five minutes to twenty five minute periods, morning and afternoon. It must be realized that actual rest periods are not universally necessary nor helpful. Work on long automatic machine processes, such as machine boring and cutting, provide intervals of rest for the operators and this then would make actual rest periods superfluous. However, an operator of an above mentioned machine should have a chair present where he can relax while the machine is carrying out its process. In most plants that I have seen a chair has been provided.

Along with rest periods one might mention again the number of working hours per day. During previous periods a workman was forced to work from sunrise to sunset. Then the ten hour schedule came into being and now the eight hour schedule. It has been proven that an employee can produce just as much in eight hours as they formerly were doing in ten hours. During the business depression, which immediately followed the

close of the last war the Crane Company of Chicago found their warehouse becoming overstocked. They reduced their working day from eight hours to seven hours in the belief that their production would be decreased, but instead the men were producing just as much in seven hours as they formerly had been producing in eight hours.

It is true that no one can complete even a moderately industrial days work without becoming more or less fatigued. This is called the necessary fatigue, but the amount of necessary fatigue can be reduced by rest periods, providing chairs when convenient, etc., and by paying attention to the physical, physiological and psychological peculiarities of the individual worker. This is commonly known as the fitness of the man for his work in order to reduce to a minimum the necessary fatigue. First, if the job requires a considerable amount of muscular exertion the worker should be tested for total muscular strength in order that a man of less muscular strength will not be wearing himself out on a job which requires too much muscular exertion. Visual observation will not always suffice because the man which may appear to be the stronger in reality may not be so, so spring balance instruments are used. The ordinary dynanometers fail in this test. Then the physiological efficiency is tested. This is based on the fact that a sudden expenditure of energy such as running upstairs or lifting a heavy weight will cause a change of pulse rate and variations in blood pressure. The success in which the human body can compensate for a sudden putput of energy or change of position is

a fair measure of a body's physiological efficiency. This test is performed by having the individual change from a reclining to a standing position and in the normal there will be an increase of 10 mm. of mercury and practically no increase in the heart rate. In a person weakened by dissipation, overwork, lack of sleep, or disease, the blood pressure will tend not to rise but to fall and the heart rate will often increase as much as 40 beats per minute.

There is at present no method for determining in advance how well an individual may stand the strain of hos job over long periods. Therefore, the medical and employment departments are guided by medical histories for information regarding serious illnesses, operations, specific diatheses and pathological conditions which might be expected to interfere with endurance.

Intelligence and trade tests which are given are essentially the same tests which were given in the army during the past war. The trade tests are devised to test the dexterity and coordination of the person. These intelligence and trade tests while used by a few concerns are not universally used.

The physical, physiological and endurance tests are used by the progressive companies and their efficiency has been proven by increased production. These tests also lessen any discontent which is so easily aroused in an overworked and "tired out" workman due to having been placed in a job in which he did not fit. At the International Harvester

Company in Chicago one never saw a weak man doing a strong man's job and those which were alert mentally were very soon placed in more responsible positions.

Another factor in the prevention of fatigue is the elimination of all unnecessary movements and arrange movements so that they flow into each other when performing a necessary task. Industry has done this but the factor in mind probably has not been reduction in fatigure but increase in production per period of time. Fatigue in a great many instances is reduced by harmonizing the surroundings. By this is meant reduction in noise, fear of injuring oneself, bad atmosphere, long spells of working hours, and exposure to great heat are examples. It is known that reduction of unnecessary noise is a great aid especially for employees who are engaged in mental work. Fear is also known to cause fatigue very rapidly. These above mentioned conditions are obvious in the minds of modern employers and attempts are made to remedy them. Some companies provide homes for their employees. This plan is prevalent in the mining and steel companies. The homes are inexoensive but built so as to provide comfort, warmth and hygienic surroundings. The providing of homes which are healthful places in which to live, the employees general physical condition is maintained and does noy make him so susceptible to infection and disease. Many companies provide recreational centers for their employees where they can gather after working hours and obtain recreation under healthful conditions. In many of these centers swimming pools and

shower baths are provided. Most companies maintain a cafeteria in which their employees are insured of a good wholesome meal at a reasonable cost. The International HarvesterCompany allowed dairy companies to deliver milk in every department in their plants. This gave their employees the benefit of a beverage with their lunch which was fresh and wholesome.

Lead comes to the workman usually as dust, sometimes as fumes and often carried to the mouth by deposits on hands and other objects. In many of the most modern plants good systems of ventilation have been installed. Certain of the processes are carried out under hoods with a strong draft, in cabinets, or in special rooms with an air current so arranged that the lead is kept away from the mouth, nose, hands, and clothes, of those who are exposed. On the part of the workman the prevention of lead poisoning consists in cleanliness of the hands and of the finger nails, frequent bathing, and the use of special clothing while at work. Care must be taken not to carry the fingers which may be contaminated with lead to the mouth and nose, and to wash the hands thoroughly before eating. Workmen should never take their lunch in the rooms where there is a suspicion of lead in the air. The hazard of chewing tobacco under such circumstances is obvious. Respiration may afford protection in emergency and short exposure, but cannot be depended on as a routine precaution. Special rooms for the clothes of workmen and special overalls should be provided for those who are

exposed to lead. Plants having an efficient medical department strive to impress upon the employees mind the above information. Workmen should alternate and not remain too long in the dangerous departments and hand labor should be supplanted by machinery as much as possible.

Another radical measure which can be used in the paint industry is to substitute zinc white for lead paints. Zinc may be used as a substiture for lead, especially in indoor work; in fact, this has been required by law in France. White lead appears to be superior to zinc in outdoor work. Some operations in the storage battery industry require special precautions to fit the circumstances in the prevention of poisoning, Milk taken frequently and in generous amounts has long been known to be preventative. It was formerly believed that milk acted by keeping down the acidity of the gastric juice but it now appears that milk is preventative because it is rich in calcium which keeps the lead stored safely in the bones.

Molding or casting grids differs in no way from that in any department that is manufacturing lead goods. The hood and exhaust are all that is needed here. Wooden floors are not allowed for it is impossible to keep them clean from particles of lead. The making of paste involves opening kegs and dumping dry red lead and litharge and blending them. Hand mixing is no longer done on a large scale. The mixing department should be separate from the dumping and blending department and if it is not there is usually a dangerous amount of oxide dust in

the air. The mixers in modern plants are tightly closed so no lead dust gets into the air. Where hand mixing is done the mixer stands on a high platform and works at a steel covered bench under a hood the edge of which comes against the upper part of his chest. A pane of glass in the hood and a light underneath allow him to see his work. An inward draft under the hood protects the employee from the escape of dust. Pasting plates together has always been accomplished by a great deal of dust . The Eb̀glish factories maintain a continuous supply of water on the floor. The men stand on wooden platforms, wear wooden shoes and washable suits and caps. In the United States good exhaust systems are installed. In the Willard Storage Battery Company everything is kept as wet as possible in the pasting room. The pasting machine is wet the floor which slopes to a drain is washed every night and sprinkled frequently with water containing magnesium sulphate. The salt collects water from the air and as the water drains off there is left over the floor a light coating of the salt which produces a dampness, especially where the mens feet crush it. The Prest-O-Lite Company mix saw dust with the magnesium sulphate. This saw dust can be gathered up and sent to the furnace for the recovery of the oxides. Paste from pasting benches is never allowed to fall on the floor where it dries and forms dust. Suitable devices have been devised to catch fallen bits of paste. The benches used for pasting are washed at noon and at night.

The drying or pickling of plates is also accompanied by much oxide dust unless precautions are taken against it. The Prest-O-Lite

Company use a very good method of prevention in this department. The pasted plates are carried along a traveling belt, while the plates are still wet they are placed in boxes with handles and are dried in these without further handling. They go to a storage room which is a light clean room with a damp floor, in the same boxes which are conveyed along traveling belts and need no handling. As soon as a box is emptied it is washed out. The traveling belts are kept clean by a stiff brush which is fastened below the belt. This brush dips in a pan of water and brushes the belt as it passes down on its return journey.

Phosphorous poisoning in industry is now fairly well controlled. It was of much concern before the Esch Law was passed in 1912. This law placed a prohibitive tax on white phosphorous matches. It was in the match industry that phosphorous poisoning and particularly phossy jaw was affecting the laborers. At the present time phosphorous poisoning is prevented by the use of good ventilation which draws the fumes away from the laborer. Phosphorous fumes enter through defective teeth, reaching the periostium jaw bones where they set up necrosis. It is obvious that teeth free from defects is a factor in the prevention.

The best means of preventing fume fever from zinc oxide are to reduce the fume concentration below that which is injurious and to make exposures as brief as possible. Suitable methods of ventilation can be used in most instances reduce the fume concentration below that which is injurious. The best method is to pass the fume laden air through bag filters. This air filtered free of fume can then be recirculated through

the foundry and results in an economic saving of heat during the winter months. In plants where men are subjected to brief or intermittent exposures respirators are used of a type discussed later in this paper.

Mining is a dangerous and unhealthy occupation, due to underground employment, high temperatures, humidity, poor air, and exposure to poisonous gases. Much of this has been remedied the past few years. The prevention of deleterious effect from mine gases are very interesting. The gases encountered in the mines are carbon dioxide, carbon monoxide, marsh gas, hydrogen sulphide and the nitrogen oxides. Marsh gas CH_4 is what the miners call fire damp. When this is present in the air in any quantity above two-tenths per cent it makes a cap of luminous flame over a lamp which gives warning of the danger point, for air containing from five to thirteen per cent is explosive.

Black damp is a mixture of N and CO_2 and it usually occurs in coal mines. This gas causes fatal accidents by suffocation. Miners test for this gas by lowering a candle into a shaft and if it goes out the proportion of black damp is more than fifteen and eight-tenths per cent. This effect is due to lack of oxygen for a candle will not burn with less than 17% of oxygen in the air. Black damp causes a chain of symptoms which are due to lack of oxygen.

The conditions of mines have been greatly improved during the last few years. Systems of ventilation have been installed, safety

lamps are being used with more attention given to them, reduction in amount of dust by better ventilation and spraying and disappearance of nystagmus by better illumination in the form of electricity. Miner's nystagmus is a rather rare condition in this country, but it is found frequently in European countries. This disease is occupational and restricted to coal miners working with hand safety lamps which give only one-fifth the light of a naked candle. Such light rays, reflected from black coal, afford an illumination below the limit of the power of the eyes for adaption. The prevention used is better illumination. The disease has practically disappeared in this country since the introduction of electrical lighting in the mines.

Arsenical poisoning in industry is caused in one of two ways: first, by dust inhaled and swallowed, second, by absorption of arsenic in the form of gas. The latter is much more serious. Arsenical dusts are encountered in cleaning out fluex and baghouses in smelters, in paris green manufacture, in the making of lead arsenate and in use of white arsenic in many purposes. Prevention of this is accomplished mainly by the installation of efficient ventilation systems, which if installed properly serve the purpose very well.

The prevention of mercury poisoning is similar to that of lead. The air must be kept free from mercury, therefore proper and efficient ventilating systems, hoods with forced drafts, etc., are used to keep

mercury fumes from the workmen. Rubber gloves are very efficient as they prevent absorption through the hands and can be taken off after working hours, therefore, preventing carrying of mercury to the mouth. Here as in lead the changing of clothing and scrupulous cleanlinless are essential.

Carbon monoxide gas is very important in that there are a great many industries in which the fumes are present as well as in garages. The prevention to the workmen is simple in that efficient ventilation handles the situation very efficiently.

Hydrocyanic acid gas in air in very dangerous. A simple test has been devised and used which detects the presence of the gas and the amount. This gas is given off in dengerous quantities from the potassium or sodium cyanide used in the extraction of gold and silver from ore and from other metallurgical and chemical operations. The gas is widely used to fumigate buildings, ships and green houses, and in agriculture to kill rats, mice and insects. Wherever cyanide gas fumes are present thorough ventilation is necessary in order to make the air safe to breath. The Bureau of LMines has perfected the color test which is simple and convenient for use. When proper procedures are followed the shade of color of the test papers after being exposed to the gas are compared with a color chart. By means of this test an estimation of hydrocyanide acid from 25 to 1000 parts per million can be obtained. Unprotected persons

should not enter atmospheres containing hydrocyanide gas unless tests show concentration below 100 parts 3er million. The following is a short outline of the directions for making the test. The operator must wear a gas mask with soda-lime filled canister. A color chart and watch is put in a convenient position. A copper sulphate paper is dipped into a guaicum tincture and the time for the development of the color is determined in accordance to the indications on the chart. From these results the parts of hydrocyanide acid can be calculated. This test is used of late by fumigators of ships and in the industries extracting gold and silver from the crude ore.

There are many toxic hazards prevalent in the cleaning industry. Benzol is used for cleaning. The inhaling of benzol vapors over long periods of time does harm to the blood forming mechanism causing an anaemia to develope. The methods used to avoid and prevent anaemia from the above cause is proper ventilation. If the concentrations are very high gas masks can be worn, or hose masks. These masks will protect the worker even in a benzol saturated atmosphere. The above methods apply to gasoline and naphtha vapors which are encountered in dry cleaning establishments also.

High temperatures in the paper industry are frequently met with in the recovery of sulphate and soda, in the grinder room, digester house, machine room and steam plant. It is known that a definite correlation exists between health, efficiency and ventilation, therefore

good ventilation protects health and increases the efficiency of the plant. It is in the machine room that the problem of ventilation is most acute. Here the huge surfaces of the dryer cylinders radiate a tremendous amount of heat. A large machine room in which there are two 150 inch machines with 40 dryers each would require a floor space of 9,000 square feet, while the surface offered by the dryer rolls would be almost 16,000 square feet. These dryer rolls are heated to about 212°F and therefore the loss of heat and moisture is tremendous. Methods used for the mitigation of heat and humidity are as follows: The problem is to make conditions as favorable as possible for rapid evaporation. While heat is necessary, low humidity and rapid air movement is desirable. There are four systems of ventilation is use in the paper industry: Nautral, plenum, exhaust, and combined. The combined is much the best system and is frequently seen in connection with large machines. Usually a large hood is placed over the dryer cylinders. Air is blown from the outside through the heaters if necessary to the machine room and is removed by exhaust fans placed in stacks leading from the hood. This method while efficient is wasteful of heat, so some concerns have obtained their air already heated from other parts of the mill or else use the exhaust air to heat other departments. Where the temperature in a room is 82.50 F. and the humidity is 53 per cent it is theoretically necessary to provide an air movement of five miles per hour. Such an air velocity would be perceptible but not unpleasant. This could be provided by fans and should occur at the level of the workmen's bodies

and faces. In most of the plants at present the air comes in from above and hardly affects the men at all, but in the more modern plants the above discussed method is used.

The measures which have been taken to prevent the occurence of silicosis and tuberculosis may be roughly divided into: (1) those of a mechanical nature, and (2) those of a medical nature.

Schedule XIX of the Report upon the work of the Miner's Phthisis Medical Bureau for the year 1918 to 1919 contains a historical summary of the mechanical precautions which had been adopted up to that date. Practically all these precautions as well as those more recently introduced, have been directed against the creation of dust during work, and towards supplying of the workers with air which is free drom dust. The most beneficial of the precautionary measures are as follows:

1. Prohibition of machine drills unless provided with an axial water feed.

2. Prohibition of the blasting of the "cut and round" separately in the same shift.

3. Providing that blasting shall take place only once in 24 hours, and always at the end of the shift.

4. Prohibition of working in, or entering, any place the air of which contains dust or fumes detectable by the unaided senses.

5. Securing an adequate supply of clean air and water for dust prevention shall be furnished to all working places.

6. Providing that no broken rock shall be moved unless thoroughly wetted.

The precautionary measures of a medical nature fall within the province of the medical bureau. The medical measures which are of a precautionary or preventive nature are as follows:

1. A person who is not a miner may not go underground for any purpose unless he has been examined by the medical bureau and certified not to be suffering from tuberculosis.

2. No man may become a miner until he has been certified by the medical bureau to be free from disease of the lungs and physically fit in other respects to follow the occupation. A radiograph of the chest forms an essential part of the examination.

3. Every man who is employed in underground work must be examined at a periodical examination, preferably once every six months. This examination includes the taking of a radiograph.

4. The discovery at a periodical examination of any disease calling for medical treatment, or of a condition considered premonitory of tuberculosis disease, is informed to the miner. He is then advised to consult his own physician about it.

5. Laboratory examinations of sputum, urine and blood, are undertaken as often as deemed necessary, and without any restrictions as to number.

6. All examinations are carried out free of cost to the examinees, when an employed miner attends this examination his days wages are guaranteed by his employer.

Fine nickel dust is a factor in the cause of the nickle rash but only when the environment is hot and much sweating is produced. Thus most cases occur during the summer months. Normally perspiration is slightly acid or neutral but after a time it becomes alkaline and an alkaline skin reduces its ability to natural protection. An increased skin temperature allied with an alkaline sweat increases the irritab-

ility of the exposed parts, lowers their resistance and increases their susceptibility to irritation. The prevention, therefore, is proper ventilation so as to remove nickel dust and carry it away from the worker and also keep the body cool. It has also been suggested that oral administration of calcium chloride which counteracts tendency toward alkalosis produced by excessive sweating can be used as a preventative measure to keep the skin healthy. It has been shown that in the ingestion of calcium chloride there is an absorption of the chlorine from the alimentary tract and not the calcium. Thus an increase in the hydrogen into concentration of the blood is produced.

Bakers itch is a disease of the skin which is more common in those employed who are actually handling the dough. The suggestions for the prevention of bakers itch will now be discussed. The more general use of dough making machines will aid greatly in prevention as an employee is not compelled to come in contact with the dough. The installation of proper washing facilities such as hot water, suitable soap and a sufficient number of towels enables the employees to entirely remove the dough which is the irritating substance. The maintenance of the employees general physical condition by suitable ventilating aids greatly. The use of rubber gauntlets by those who are suffering from the condition so that its course will not be prolonged. This is also a good preventative measure but employees greatly dislike to wear them.

Wool sorters disease or pulmonic anthrax is prevented to a

large extent by proper ventilation. The ventilation is installed in such a manner that the air current moves away from a worker and does not allow the dust to come in contact with him or be inhaled into his lungs.

Caisson is a disease which formerly was prevalent among those working under increased atmospheric pressure. In order to avoid the occurence of caisson disease among workers under high pressure, rules have been formulated and in some instances have been made obligatory by law. The rules apply to the selection of the workers, length of exposures and the duration and type of decompression. Individuals are excluded who present constitutional defects, who are over fifty years of age and who are obese. Fifty pound gage pressure except in emergencies forms an upper limit beyond which work should not be continued for more than very brief periods. New York State has laws governing the time of exposure. This varies universally with the pressure and ranges from 7-1/2 hours at 22 pounds to 1 hour at 50 pounds. This law is to be revised in the near future because the time and mode of decompression is the most important element. There are two types of decompression. The uniform and the stage method. In the former the pressure is lowered uniformly until atmospheric pressure is reached. The intention is that the time should be such that the accumulated nitrogen may diffuse off to a safe level or saturation. This would be 10 to 15 pounds gage pressure. The New York law requires by the uniform method that time

required for decompression is 18-2/3 minutes at 28 pounds to 50 minutes at 50 pounds.

In the stage method the pressure is lowered immediately and rapidly to a point short of danger, but sufficiently low to induce rapid diffucion of nitrogen out of the body. After an interval of time the pressure is again lowered. This process is continued until 10 pounds gage pressure has been reached.

The last process consumes less time and is more efficient both physically and physiologically. In the uniform method elimination of nitrogen is at first slow because the difference of pressure within and without the body is slight. At the end of the uniform decompression the pressure within the body is still high while without is low. Therefore, there is a risk of bubble formation unless the decompression of process is very long. Stage decompression aims to use the entire period to insure a maximum safe rate of elimination. Therefore, at the end of the period the amount of nitrogen remaining in the body would be much less with the stage method than with the uniform method.

One or the other of the above two methods are used in industry today and if used properly prevent caisson disease.

There are a large number of industrial processes which while not technically dust hazards are nevertheless associated with the production of sufficient dust to make some kind of protection desirable so

as to prevent irritation of the nose and throat. Such conditions are those connected with the packing of dried soap and manufacture of powders of many varieties. A mask has been devised for this purpose and is shown in Figure 5. This mask can also be used by janitoes and grain workers and by many other persons when doing work in a dusty atmosphere. The dust in grain elevators is not particularly harmful but causes extreme irritation and congestion in the nose and throat and discomforts therefrom. The mask covers the mouth and nose and is cool and clean and is efficient for the industries just mentioned above. The muslin which may be used double or single is never to be washed because it is the small fluff on the muslin that is essential to adequate filtration and with washing this fluff is destroyed.

In many industrial operations the liberation into the air of harmful dusts and fumes cannot be avoided. The conditions may often be improved by general ventilation, by local exhaust, ventilation and air currents or by the watering and spraying of dusty material. Even with these precautions the dust remaining in the air may still be dangerous.

In the case of toxic and irrespirable gases, where the systemic effects of inhalation are rapid, the need for protection is generally recognized. Suitable gas masks, oxygen breathing apparatus or hose masks are available. In locations where dusts and fumes are concerned, it is much more difficult to arouse interest in protective devices. The deleterious effect of inhalation often become apparent only after repeated

exposure, sometimes after a few weeks and sometimes only after years.

By dusts is meant finely divided solid particles ranging in size from less than 1 micron up to 150 microns. In industry dust clouds coming in this classification are formed by operations such as grinding, crushing, drilling, abd blasting.

Fumes are liquid or solid particles from about 0.2 to 1 micron in diameter. These are found in distillation, condensation, and combustion. Acid mists, ammonia chloride, lead and zinc oxide can be produced in the form of fumes.

For industrial purposes smokes are liquid or solid particles about 0.3 micron or less in diameter which are the products of incomplete combustion of carbonaceous matter, as for example gas, oil, or lamp blacks, tobacco, wood or coal smokes.

Gas masks are designed to absorb small amounts of toxic gases. The chemicals which accomplish this absorption are usually in the form of granules about 3 mm. in diameter arranged in one or more layers a few centimeters deep. Due to the mutual affinity of these granules and gas molecules and to the incessant molecular motion of the latter, a high absorption efficiency is obtained, with little increased resistance to breathing. Most gas masks are provided with felted filters at the entrance to the canister or between the layers of chemicals within.

Dust particles suspended in air are best caught by the

filtration method. The commonest form of dust mask is what is called the Pig Snout Respirator (Figure VI). This is an alluminum drum devised so filter pads can be placed on the distal end and the proximal end is made so as to fit tightly around the nose and mouth by means of a rubber pad. Opening from the side of the aluminum drum is a rubber flap expiration valve is placed. The filters are usually made out of felted cotton and sometimes wet sponges. These masks are not expensive.

Another very efficient dust mask is the Burrell mask (Figure VII or VIII). This mask has a filtering area of about 840 square centimeters and both sides serve as filters. The filters are placed in a bag hanging on the chest. These filters are reinforced by a thin sheet of corrugated wire netting which prevents collapse on inhaling. The filters are covered with a coarse canvas bag perforated with several holes through which air enters. The filters are used with a gas mask face piece. If the filter becomes plugged from use, they can be cleaned off by blowing compressed air into the threaded junction.

This mask affords excellent protection against dust and against a great many fumes. It is eight per cent efficient in removing a fine smoke such as tobacco. It has a low resistance to breathing and very little tendency to plug on long usage. This mask is more efficient than is needed for many industrial dust hazards and like the gas mask is expensive.

In the industrial process of collecting zinc oxide fume, bag filters made of coarse and heavy cotton are sometimes used. Some fume passes through these bags at first, but after a few minutes the surface meshes of the fabric become plugged by the fume and the efficiency increases to practically 100 per cent. The bags are then effective and need no further attention until enough material has accumulated on the inner surface to make the resistance to air flow prohibitive. The bags are then shaken, the collected material removed, and the cycle repeated.

A special gas mask has been constructed for protection against ammonia gas. This mask forms a pocket over the face and allows breathing through the nose. It consists of a face piece with non-shatter eye glasses. This is attached by means of a corrugated tube to a canister supported on the wearers chest by a harness. It has a disc valve on the bottom to prevent exhaustion through the canister. The canister is filled with impregnated activated charcoal about 750 cc. in volume and weighing about 520 grams. This material is supported above the check valve by a dome of wire screen covered with toweling. Above a granular material is a filter of absorbent cotton between wire screens, and all materials are held in place by pressure from strong springs. This mask protects in any concentration that can be borne readily by the skin. A 2% concentration causes severe skin irritation and the mask protects to 3% concentration. Therefore, the worker if he experiences no skin irritation is safe from respiratory irritation.

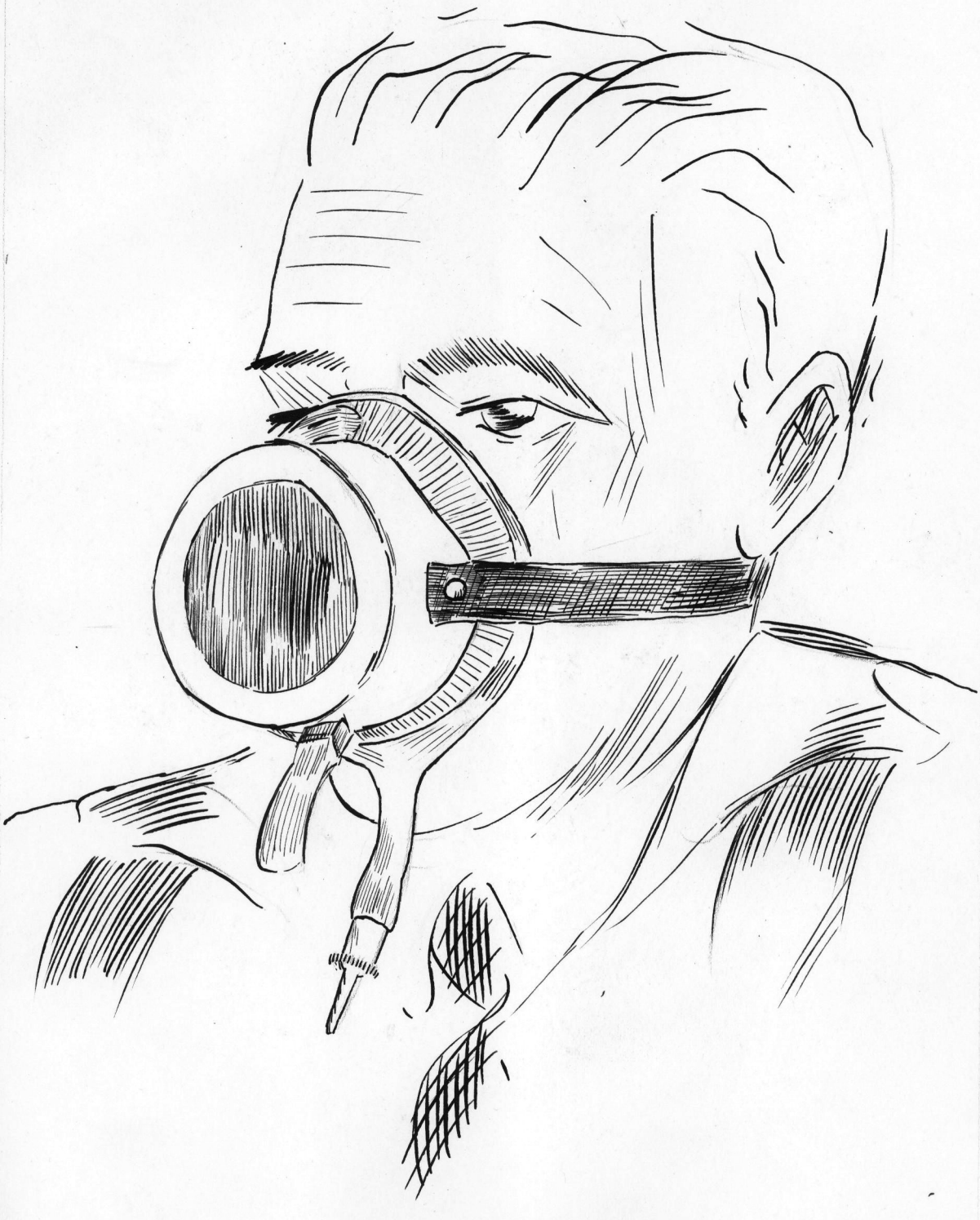
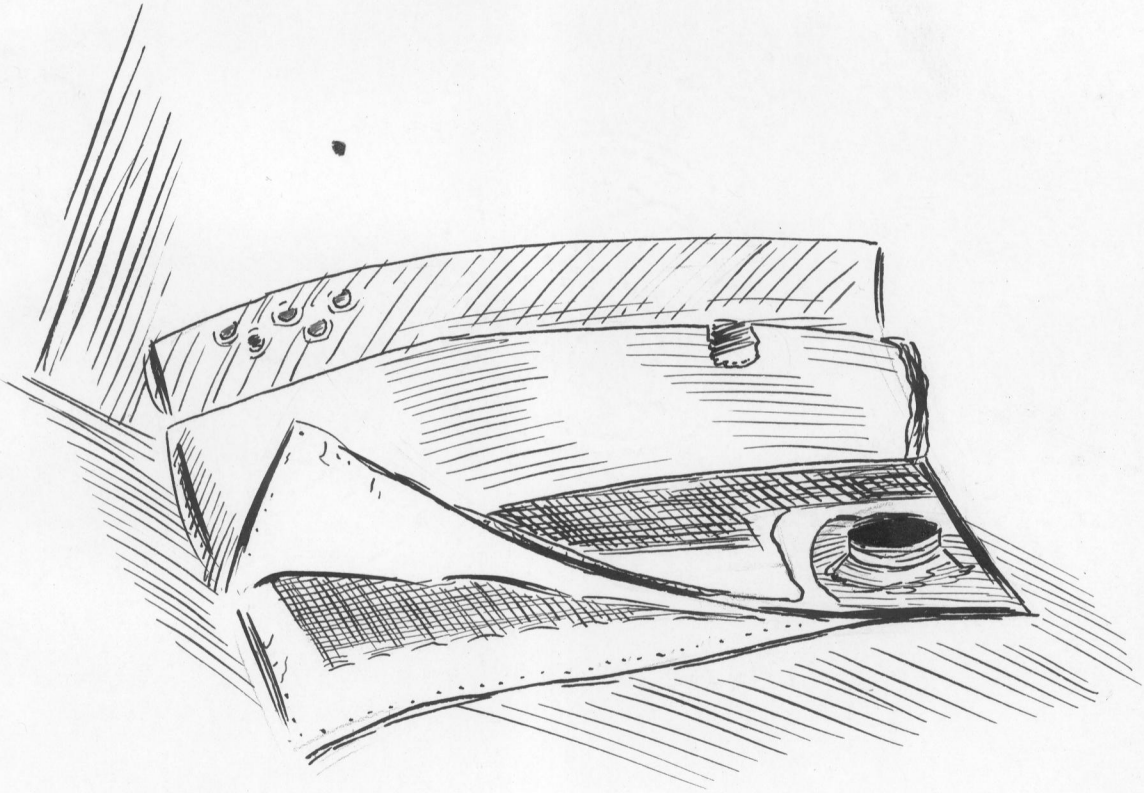


Fig VI

Figure VI

Fig VII

Figure VII



VIII

Figure VIII

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Approved by A. D. Evans
Prof. of Medicine.

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