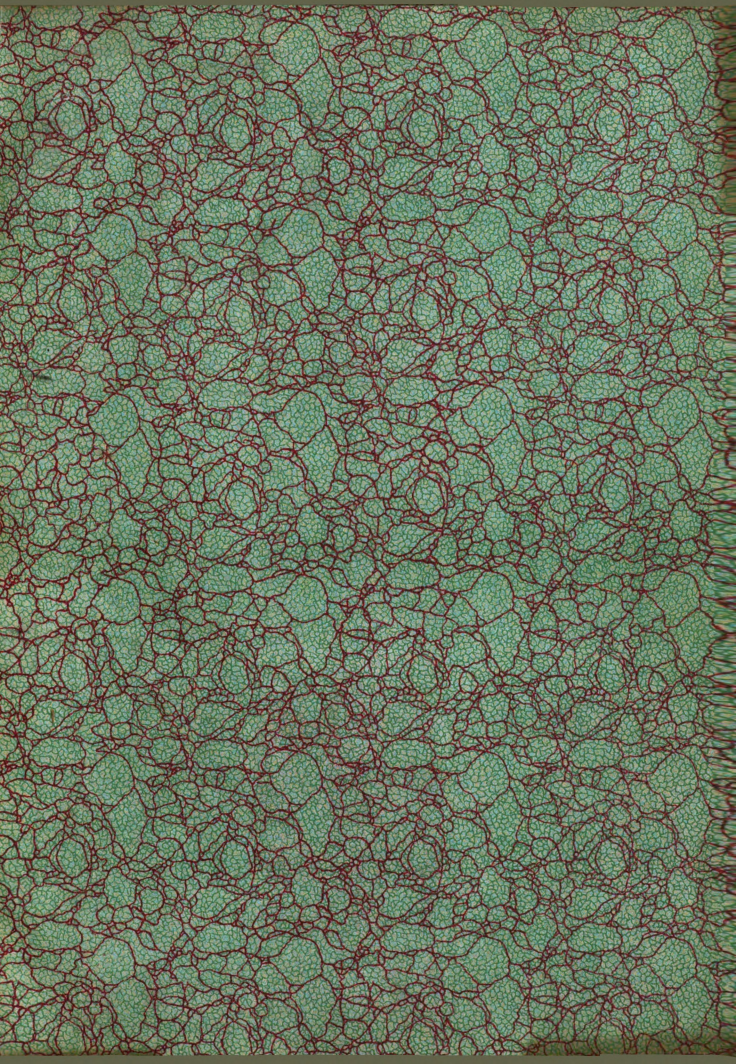


S A F E T Y D E V I C E S

A S A P P L I E D

T O T H E M A N U F A C T U R I N G P L A N T.

B Y

H E N R Y J. M A S T E N B R O O K, B. S.

"S A F E T Y F I R S T"

M A Y 1, 1 9 1 2.

THESIS

INTRODUCTION

The subject of safety devices for the prevention of industrial accidents is so broad that it would be impractical for any one person to attempt a general discussion of the subject. We must look for specialization along various lines of engineering. The expert, competant to provide for the ordinary manufacturing plant could hardly be expected to provide equally well for the railroad system or the mine.

In the following pages only such safeguards as apply to the manufacturing plant will be considered, and these will be treated in as brief and concise a manner as possible. Many devices in common use are of little value and a few are a menance in themselves. Such devices will not be described, or if they are, it will be for the purpose of warning against their use. If an appliance is known to be patented this fact will be stated, or if it is adapted from some published article due credit will be given. It will only be possible however to give credit in a few cases as a great majority of the safeguards described are those that have come under the observation of the writer and their origin is unknown to him.

The illustrations shown will be general in character intended to illustrate the principle involved and , with a few exceptions, will not apply

directly to specific cases. They are intended more particularly as a guide to the designer.

The writer believes the subject of safety devices is one that ought to be given more attention in the technical school as the average graduate has little conception of what constitutes an adequate safeguard. The proper place to equip a machine with safeguards is in the drafting room when the machine is being designed. It is therefore of prime importance that the designer have a clear conception of what is necessary in this respect. It has been the writer's experience that the average designer is woefully deficient in this respect. This is a wrong condition of affairs and one that should be corrected at the earliest possible moment. The technicel school could do much towards advancing the knowledge of the student along these lines without unduly interfering with the regular work. It should be incorporated as a part of the regular courses in machine design and shop methods.

The campaign now under way for lessening the number of industrial accidents must necessarily be largely a campaign of education. The workman must be taught to avoid dangerous places, they must be taught that all moving machinery is dangerous even though it may look innocent, they must be taught to keep in mind at all times the necessity for care. It is thus that habits are formed and when "CAUTION BECOMES A HABIT ACCIDENTS WILL BE FEW."

NECESSITY FOR SAFETY DEVICES

It is not possible to obtain accurate statistics regarding the number of industrial accidents in the United States. Conservative estimates made by the Bureau of Labor places the total mortality among adult male wage earners at from 30,000 to 35,000 anually. In addition to these there are approximately two million non-fatal accidents annally, entailing a vast amount of suffering and financial loss, as well as shortening the natural life of the victim or leaving him in a crippled condition.

The number of these accidents that could be prevented by the installation of proper safety devices can only be estimated but we can form a fair estimate by comparison with some country whose statistics are available. The German government has collected exact information along these lines in connection with the Workmens Compensation insurance in that country. From this it appears that about 58 per cent of the accidents are the result of negligence on the part of the employer or employee, and therefore preventable, and 42 per cent to the inevitable risks of employment. Following is a classified list of the causes of accidents as published:

Inevitable risk----------	42.05per cent.
Want of skill and carelessness----	20.25 " "
Want of guards----------	7.82 " "
Deficient factory arrangements----	7.15 " "

Acting against rules---------- 5.14 per cent.
Fault of other (third) person----- 5.28 " "
Fault of employers and workmen---- 4.66 " "
Not using guards---------- 1.92 " "
Insufficient instruction---------- 1.84 " "
Superior force, casualty, etc.---- 1.31 " "
Carelessness---------- 1.19 " "
Unfit clothes---------- 0.49 " "

In considering the above list we must remember that the subject of accident prevention has been given a great deal more attention there than in the United States. The Workmens Compensation laws encourage the invention and application of safety devices and their use has become general throuought the Empire. It is therefore probable that the per cent of preventable accidents in the United States is very much more than 58 per cent, probably as high as 70 per cent and possibly more.

Disregarding the humanitarian feature and considering the subject purely from the financial standpoint the loss is staggering. During 1908 over $22,000,000 was paid in premiums to the insurance companies for liability insurance. This represents only a small portion of the loss the total amount of which it is impossible to estimate with any degree of accuracy. This certainly constitutes a serious drain upor our industries and one that there is no question could be lessened in a very marked degree by the installation of proper safeguards.

It is beyond the province of this thesis to discuss at any length the subjects of libility insurance or workmans compensation. Many factory owners are no longer carrying libility insurance. They realize it is cheaper to prevent accidents than to pay for them and with the factory that is well equipped with safety devices the amount paid for injuries is invariably less than the cost of insurance. The subject of compensating for unavoidable accidents should go hand in hand with that of accident prevention. Some method should be devised whereby the amount of compensation can be determined without the expense and delay now incident to legal methods.

Some of the larger industries, notably the United States Steel Corporation, have adopted a fixed scale of compensation for death or injuries which they pay without question provided no legal measures are taken. It is the writers opinion that this is the correct solution of the problem and to make it applicable to all industries will require governmental aid and supervision.

WHAT CONSTITUTES A SAFETY DEVICE.

The term "Safety Device" as used in this thesis does not mean merely a guard for some dangerous portion of a machine BUT INCLUDES ALL PREVENTATIVE MEASURES, NO MATTER WHAT THEIR NATURE, THAT TEND TO MAKE WORKING CONDITIONS MORE SAFE. Any condition or apparatus that will tend to lessen the dan-

ger from fire, for instance, or facilitate the escape of the employees from the building in case of fire is as truly a safety device as a gear guard.

THE TIME TO PROVIDE SAFETY DEVICES.

The proper time to provide safeguards is when the plant is being erected or the machine or apparatus is being built. A little attention given to the grouping and arrangement of buildings, providing open passage ways, fire exits, doors opening outward, adequate lighting and ventilation and strict compliance with the underwriters rules will lessen to a marked degree the danger of accidental injury to employees, without materially increasing the cost of construction. When a machine is being designed the necessary safeguards can usually be applied at small expense and they can be so designed that they will harmonize with the lines of the machine and in most cases improve its appearance. When machinery is not so guarded it falls upon the user to make it safe by means of patented devices or home made safeguards. It is frequently very difficult to provide efficient safeguards on machines for which no provision has been made for them in the original design owing to lack of clearance or other conditions. It can usually be done however although the result may not be very pleasing to the eye, depending upon the amount of time and money spent upon their design and construction.

POINTS TO BE CONSIDERED IN THE DESIGN OF SAFETY DEVICES.

The first question to be asked in designing a safety device is, "Does it protect?" A device that only partly protects is often worse than none at all as it conveys a false sense of security and causes the workman to wholly rely upon it for protection thus inducing him to take chances that he otherwise would not and which the device will not protect against. An incident in point was a large gear provided with a guard that extended only part way around. A workman in attempting to wipe off the guard with a piece of waste allowed his finger to project over the end of the guard. It was caught and crushed between the gear teeth and guard. Of course the man should not have been cleaning the machine while in operation but men frequently do foolish things. If the gear had not been guarded at all he would not have attempted it or if it had been completely guarded the accident could not have occured. Thus a safety device to be wholly efficient must be "fool proof" or so constructed as to render injury impossible as long as the device is in operation. This of course is the ideal condition which it is often impossible to achieve but it should always be the aim of the designer to approach this condition as near as possible.

Many machines can be completely and easily guarded, others by their very nature are, and always will be, dangerous. With this class the

designer must study the operation of the machine, find its most dangerous features and try to reduce the danger to a minimum. If a device only partly protects it is good policy to have a notice to that effect prominently displayed stating clearly the nature of the danger.

A very important feature in the design of safeguards is to have them of such a character that there will be no temptation on the part of the workman to remove them or leave them off permanently. The ideal condition is to have them so incorporated in the design that the machine will be inoperative without them thus making their removal impossible. Very often guards can be so arranged that they will be attached permanently to the machine by means of hinges in such a way that when they are not in use they will swing out into the operators way thus forcing him to keep them in position.

All safeguards should be STRONG and FIRMLY AND RIGIDLY HELD IN POSITION. In the case of gear and similar guards it is usually not necessary to remove them very often. In such cases they should be firmly bolted to the machine frame or floor, frequently they can be locked with a padlock so that the operator cannot remove them. It is always advisable and frequently necessary in this class of guards to provide small doors for oiling or inspection.

Guards should not be cumbersome, they should

not make the operation of the machine more difficult and they should not curtail production. The last is important as the employer, in these times of rapid production and close competition, will hesitate to approve any device that will reduce production. On the other hand, if the operator is a piece worker, he is as anxious to turn out a good days work as the employer and he will rebel at anything that hampers him although he will not hesitate to sue the company in case of injury. in some cases therefore it is advisable to curtail production to some extent if thereby the number of accidents may be reduced.

Lastly, guards should be as neat and present as good an appearance as possible. The majoraty of manufacturers are proud of their factory and want it to appear as neat and tidy as possible. It is not necessary for safeguards to be unsightly, in fact with a little care in their design, they can usually be made to present a better appearance than the object they cover.

ATTITUDE OF EMPLOYERS TOWARDS THE APPLICATION OF SAFETY DEVICES.

The attitude of various employers towards the application of safety devices is as varied as the personality of the men themselves. As a rule the bigger and broader minded the man the more favorably he will look upon anything that will make working conditions more safe. Nearly all of the larger industries, the Steel Corporation, The General Electric Co., The Westinghouse Co., The International Harvester Co., and many others have well organized Safety Departments presided over by able men who make a specialty of this work. These concerns are managed by able, far seeing men, who thoroughly realize that it is cheaper to prevent accidents than to pay for them. Perhaps the attitude of these companies can best be illustrated by quoting a portion of the introduction to a little pamphlet entitled "Rules and Regulations of the Illinois Steel Co." writen by E. J. Buffington, president, and destributed to every enployee.

"The Illinois Steel Company appeals to every man in its employ to exercise the greatest care for his own safety, and the safety of every fellow employee. It has always been the policy of the Illinois Steel Company to guard all dangerous machines and places on its plants and to make all operations as safe as possible. Most of the rules and regulations which follow have long been in force in its several plants. It is hoped

that in the present form, these rules and regulations will reach the hands of all the employees of the company and aid in the establishment of discipline and of habits of caution.

Every man should remember that his safety depends upon the hearty co-operation of every employ of the company in the effort to use such precautions as will make working conditions safe. If anyone is careless, he imperils the safety not only of himself but of others. Therefore, everyone must care not only for his own safety but for that of every fellow workman. As he hopes for his own safety, so must he be his brothers keeper. Accidents happen at the unexpected time. Eternal vigilance is the price of safety. If everyone will give his hearty co-operation to the suggestions which follow, he will care not only for the safety of himself but also for the safety of his fellow workman. If you are unwilling to give your hearty co-operation to these rules, regulations and suggestions, we wish you would voluntarily leave the employ of the Company. If the Company discovers that anyone in its employ is not giving his hearty co-operation to these rules, regulations and suggestions, it will summarily end his employment."

Among the instructions to foremen, we find the following: "While every man is hired to do some particular work, the safety of himself and his fellow men is more important than that work. If any man has an accident in his gang, to that

extent is he unsuccessful in his job. If he is not to blame but is only unfortunate, still he is not a valuable foreman for the Company to keep in its employ."

This clearly outlines the attitude of the Steel Company which is rapidly coming to be the attitude of most of the larger corporations.

It is among the smaller industries that we find the greatest amount of opposition. Industries managed by men of small caliber who cannot look beyond the monthly balance sheet. They will admit that conditions that have caused accidents in other plants are dangerous but they cannot see that the same conditions existing in their own plants are dangerous. They will argue that the condition has always existed and they have never had an accident, therefore, they never will. They will tell you if a place or machine is clearly dangerous the fact that the danger is evident is sufficient protection. That a man has no business around there and if he does go near and gets hurt, it is his own fault. He will also tell you that a man is a fool to get hurt, if he keeps his eyes open and looks where he is going and what he is doing he will not run into danger.

An incident related by the Aetna Life Insurance Company shows how fallacious this reasoning is. "An inspector going through a plant in Illinois observed a set screw projecting on a revolving shaft. He considered it particularly dangerous because the

shaft was near a passageway and workmen were continually going back and fourth past it. He called the managers attention to it. "Dont you think," He said, "That that set screw had better be cut off? Somebody will get hurt some day if it is left that way." "I don't think so," the manager replied, "that set screw has been like that for years. No one has ever been hurt by it. The fact that it is exposed and can be observed by anyone renders it safe from causing an accident." The manager had a habit of gesticulating when speaking, and, as he waved his arms to emphasize what he was saying, the sleeve of his coat came in contact with the set screw and caught on it, and in an instant he was whirled to death. With such a man it seems that nothing less than a serious accident will make him realize that dangerous conditions prevail."

There are three things that every factory manager must sooner or later be brought to recognize.

First:- That all moving machinery is dangerous.

Second:- That if certain conditions are dangerous in one place, then they are dangerous in every place.

Third:- That if certain safety devices are practical in one factory, then they are practical in every factory.

ATTITUDE OF EMPLOYEES TOWARD THE USE OF SAFETY DEVICES.

The rules for the prevention of industrial accidents divide themselves into two main classes_ those which primarily concern the employer and those which must be observed by the workman to protect himself against injury. It is the duty of the employer to provide such safety devices as will insure the safety of the employee and it is the duty of the employee to use the devices so provided and not take unnecessary chances. It would seem that, inas-much as the devices are installed for the benefit of the workman, he would be willing to use them but, strange as it may seem, such is not the case. Hence it falls upon the employer not only to provide safety devices but to see that they are used. It is frequently necessary to adopt the most stringent measures before the co-operation of the workman can be obtained. It is difficult to understand just why this should be so. It seems to be a trait of human nature that some men find a certain enjoyment in courting danger. The same impelling force that causes a boy to want to skate over thin ice or see how wide a crack he can jump often leads a man to see how close he can run his fingers to a saw or crawl under a revolving shaft instead of walking around.

When a machine is at first provided with guards there is nearly always opposition encount-

ered on the part of the operator and if he is left to his own devices in fifty percent of the cases he will take them off at the first opportunity. He will usually claim that they are in his way and that they reduce his production. This of course is sometimes the case but it is more apt to be pure imagination. They may interfere with his doing his work is just the same way he has been accustomed to and necessitate his learning different movements but after he has been compelled to use them for a few days this feature will be gradually overcome.

The writer encountered this form of opposition only a short time ago in connection with a dust collector system he designed for some large grinders. The old system left plenty of room at the end of the shaft so a man could could stand squarely at the end when removing or replacing a wheel. In the new system this space was enclosed by the dust box for the purpose of restricting the area around the wheel and giving a higher air velocity. This made it necessary for the man to stand in front of the wheel when removing or replacing it. There was a tremendous howl arose from nearly every operator, even the foreman objecting, but no changes were made and after a couple of weeks nothing more was heard.

Another instance occurred on the same job. The work was swung under the wheel on a cradle and on certain jobs they found that when using the same

movements they had been accustomed to that the work would strike the top of the dust box. More howls. All that was necessary to eliminate the trouble was to hold the cradle at a slightly different angle yet it was impossible to convince the operators at the time that their output would not be reduced.

Another thing to be contended with is the spirit of bravado on the part of many men. They seem to resent anything which they think will reflect on their ability to take care of themselves. They are just the class of men among whom the largest per cent of accidents occur as a warning from anyone will only cause them to take greater risks. Several years ago the writer was working in a small factory in which a large amount of small stock about one half inch square by two feet long was being used. The rip sawyer cut off his finger and a new man was put on the job. This man belonged to the class just described. In passing him I noticed that he was standing directly behind the saw feeding with his left hand and with his right resting on the gage with the thumb projecting down the inside. I called his attention to the danger in case a piece should kick back but he knew all about running rip saws(I don't think he had ever run one before in his life). It was not more than ten minutes later that a piece did kick back tearing off his thumb at the first joint. There is only one way to deal with this class of men and that is to dispense

with their services as soon as they are discovered. They have no place in the modern manufacturing plant. They are not only a menance to themselves but to every employee of the plant.

METHODS OF SECURING CO-OPERATION OF EMPLOYEES.

As intimated under the previous heading the methods of securing the co-operation of employees must, in nearly all cases, be a combination of education and coercion. Men must first of all be taught to recognize that it is not an indication of cowardice to shun dangerous places but that it is a duty they owe themselves and their employer. Before a man can shun danger he must know where danger exists. Therefore when a new man is hired into a department he should be instructed regarding all dangerous machines and places in that department and should be made acquainted with all rules and regulations regarding safety that he will be expected to observe. Preferably they should be given him in printed form. He should be clearly made to understand that he will be expected to observe them under pain of instant dismissal in case he does not. It should be the duty of the foreman to see that all rules are observed and all safety devices are in place at all times. Printed notices should be posted at all dangerous places to keep the danger constantly before the mind of the employee. Everything possible should be done to keep the men constantly on the lookout for danger,

for "More important than safe machines are habits of care and watchfulness."

The employer should recognize and attempt to impress upon the mind of the employee that "eternal vigilance is the price of safety." Accidents happen when least expected so it is only by being constantly on the alert that they can be avoided. The tendency is for a man to become careless after being long employed in dangerous places. New men, if they know that danger exists, are almost invariably careful and do not often get hurt. It frequently happens however, that men are allowed to work in dangerous places in entire ignorance of the fact that danger exists. In these cases the foreman or employer are clearly at fault if accidents occur.

The best method of instructing employees in regard to dangerous places and practices and to keep the subject constantly before his mind is by the liberal use of printed notices. The first thing that will attract the attention of a visitor to any of the plants of the United States Steel Corporation is the number of DANGER and WARNING signs. They will confront him at every turn and make it impossible for him to forget that there is danger present. The signs not only indicate that there is danger but they clearly explain the nature of the danger and just what you are forbidden to do or what precautions to take.

"SAFETY FIRST" and "SAFETY BEFORE SPEED"

are the mottoes of this Company. You will find them everywhere. They are printed in the most conspicuous places on all stationery, work tickets, time slips, in all places where workman gather or pass by, on desk pads, paperweights, blotters, everywhere.

As a means of encouraging the men to take a personal interest in the subject, the plant is divided into divisions. Three workmen are chosen to act in each division as an inspection committee to serve for one month. Each member of the committee spends one day each week inspecting his division and reports after each inspection to the Safety Inspector. Each man after he has served on this committee is encouraged to continue looking for dangerous places and dangerous practices and report them to his Superintendent or the Safety Inspector. Thus in time a large portion of the employees will be on the lookout for dangerous places and customs and will have recieved a training and a sense of responsibility that will tend to materially lessen the danger of their becoming careless. It is carefully impressed upon a man that in acting in this capacity he is not acting as a spy, but as a Safety Inspector and that his duty is an important one. That in reporting a dangerous place or custom he injures no one but is protecting both himself and his fellow workman.

This policy is one that could well be imitated by many other companies. One thing must ~~be~~ constantly be kept in mind however and that is that when a notice is once posted or an order once issued it must always be enforced to the letter, and a transgression must never be allowed to go unpunished. The management must be sincere in their efforts to better conditions otherwise more harm than good is apt to result. If the workmen once get the idea that the notices, safeguards, etc. are adopted merely for effect or as a "grandstand play" on the part of the employer to secure the sympathy of the public, then he will never secure their co-operation. But if he can convince them that he is really working for their wellfare his task will be only a matter of education.

One of the most important factors in obtaining the good will and co-operation of the employees is the policy the firm adopts in dealing with accidents when they occur. The average manufacturer is still inclined to trust pretty largely to liability insurance. The injured workman is no longer regarded as one of his employees but as an enemy with a claim against the company. He is dealt with accordingly on a strictly legal basis. This attitude on the part of the employer is not one that will tend to encourage a spirit of loyalty and co-operation on the part of his employees, but quite the reverse.

On the other hand there are a few employers who do take a sincere interest in the wellfare

of their employees. This type of employer will provide an emergency room for giving first aid, he will personally cultivate the acquaintance of the doctors and nurses at the hospitals and will contribute liberally towards their support, he will also keep track of the doctors in the neighborhood of the factory, the police and ambulance corps. So when a call for help comes from that factory everybody likely to respond knows the employer personally and will take a special interest in the case. A few boxes of cigars and a few pounds of candy judicially distributed at Christmas time will work wonders in securing quick and efficient service from these quarters. The result is that when a man is injured he is promptly attended to, he recieves the best of attention at the hospital, he is visited by his employer, his family is taken care of and when he gets out he goes back to work with no thought of suing the company.

When a firm gets a reputation for taking care of its men there is no difficulty in obtaining a good class of employees or no difficulty in keeping them or in securing their co-operation in the use of safety devices or any other policy they may adopt. They may have trouble with individual men but the body of employees will be with them. It will only be necessary to provide the necessary safeguards and instruct the men in their use.

PRINCIPAL CAUSES OF INDUSTRIAL ACCIDENTS.

The principal causes of accidents in the manufacturing plant are enumerated in the following list.

Ignorance
Carelessness
Unsuitable clothing
Poor lighting
Unclean and obstructed work places
Defects of machinery and structures
Absence of Safety Devices
Insufficient room and crowding of machinery
Poor ventilation
Over work
Intoxicants

Until recently little thought has been given to the causes underlying accidents except in the absence of safeguards. Any well considered action for the prevention of accidents must be based upon a thorough study of causes. Providing safeguards will not eliminate accidents. They will help, to be sure, but their installation must be considered only as a part of the campaign not as the whole. Several of the causes enumerated in the above list only a few years ago would not have been looked upon as causes at all but they are now quite generally recognized as such. Undoubtedly as the subject is given more study and attention still more causes will become apparent.

IGNORANCE.

Ignorance of the existance of danger is one of the most prolific causes of accidents. In nearly every factory there are dangerous practices employed that have become so much of an every day occurance that they are not generally looked upon as dangerous. An instance in the authors experience served to bring this fact very forcibly to his mind. He was employed in a woodworking factory where the belt speeds were high and it was frequently necessary to throw on belts but no means of doing this was provided. The accepted method was to climb upon a barrel, step ladder or anything else that was handy and "flip" it on with the hand. One day when doing this the belt caught a ring on the little finger tearing off the ring and incidentally most of the skin from the finger. Another time while standing upon a step ladder preforming the same operation the belt went over the pully and caught between the pulley and hanger. It was quickly wound around the line shaft and pulled down the countershaft. The author jumped sideways overturning the step ladder and landing head first in a barrel just as the countershaft swung under the line shaft with sufficient force to demolish a board partition located underneath. These experiences taught him three things; that it is a dangerous practice to throw on belts with the hands, that it is dangerous to wear rings, and that it is extremely dangerous to locate pulleys

too near a hanger.

New hands should never be put to work on strange machines or amid strange surroundings without first receiving preliminary training and instruction. They should be allowed to work with and under the instruction of older hands until there can be no question that they thoroughly understand the proper and safe way to do their work. The same will apply to men transferred from one job to another.

Another thing to be considered in this connection is the aptitude of the men. A man with a heavy body and slow moving mind should not be put on a job requiring alertness of mind and quick bodily action. He may not be ignorant of the proper way to do the job but he will not possess the necessary ability either mentally or physically. And we must not forget that the heritage of curiosity has been handed down to us from the time of Mother Eve. It is astonishing how many men will pull a lever or turn a hand wheel to see what will happen or poke their fingers into the vitals of a machine to see what is in there. The free use of CAUTION and DANGER signs with explanitory notices will do much towards satisfying the curiosity and thereby avert many accidents.

Especial care should be exercised in the case of minors. They should seldom be allowed to operate very dangerous machines. The monotonous character of most machine work is so contrary to

the natural activities of the young that it will often lead to a moment of thoughtlessness and that to an accident.

Ignorance of the possibilitise of preventing accidents is by no means confined to the unskilled worker. Many skilled operators, foremen, superintendents and even managing owners have but a vague idea as to what is really dangerous and what is required to make conditions safe. It is only after one has given the matter considerable study that the real possibilities become apparent. Here is where the safety department finds itself handicapped in many cases. A firm will establish a department of safety and put a good man in charge but his recommendations have to be approved by the superintendent, a man who probably has given the matter but little attention, consequently many devices are turned down when they ought to have been approved. It is like employing a lawyer and then allowing some one who knows but little of law to overrule has advice.

A safety department to be efficient in the greatest degree must be supreme in this one particular. It must have authority to order the installation of the necessary safety devices without regard to the wishes of the superintendent. This is particularly true in cases where a company operates a number of plants. If the amount of money that can be spent for this work is limited let a

fixed appropriation be made but allow the safety department a free hand in the spending. If a competent man is in charge better results will invarably be obtained in this way.

CARELESSNESS.

Probably a larger number of accidents can be attributed to carelessness than any other one source. It is not only the most prolific cause of accidents but the most difficult to guard against. There is no safeguard that can shield a man from the consequences of his own folly. The maintainence of strict discipline and constantly calling the attention of workmen to dangerous machines and conditions by means of posted notices and the elimination of the foolhardy is about all that can be done.

A peculiar fact in this connection is, that it is usually the most valuable men from an efficiency standpoint, the intelligent, quick witted, nervy workmen, who take the greatest chances. A good illustration is the structural steel worker who will climb to the very top of a column, stand on a plate hardly large enough for his feet and calmly wave his hand to the people hundreds of feet below. The taking of such chances is foolish and wholly unnecessary and they in no way add to the workmans efficiency or earning power. Why do men do these things? It is simply a practical illustration of

the old saying that "familiarity breeds contempt". The daily proximity to dangerous machinery or conditions gradually accustoms a man to the danger so that he hardly gives it a second thought.

The worst feature is that if a man is careless he not only imperils his own safety but that of others. A load carelessly suspended from a crane, for instance, imperils the safety of every man near whom it passes. Foremen should be constantly on the watch for careless practices and put a stop to them at once. Wrestling, throwing things about and "fooling" should be absolutely prohibited. Only a few days ago a workman in a local plant lost his eye because someone carelessly threw a bolt across the room.

The enforcement of rules necessary to reduce the number of accidents from this source is one of the things in which the co-operation of the workman can only be secured through coertion. Even in Germany where the discipline maintained in the factories is almost military in its nature by far the largest number of accidents is due to carelessness. The enforcement of strict discipline is necessary and the average American, unlike the German, is not very amendable to discipline. Thus it is easily seen that this phase of the problem is a serious one and one that will require years of study and training on the part of all concerned before much progress can be made.

UNSUITABLE CLOTHING.

Unsuitable clothing is a constant source of danger around moving machinery. Loose or ragged sleeve ends, loose coats, or overalls not properly buttoned are continually in danger of being caught. The overalls should be a fairly close fit and the jacket should always be kept buttoned or preferably tucked in the overall bib. In any class of work where the hands or arms have to come near moving parts of machinery the sleeves should be rolled above the elbows. Woman operatives should always wear a cap over the head for the purpose of confining the hair as this is a source of great danger owing to its liability of being caught in belts or other rapidly moving parts due to electrical action. They should also wear a close fitting apron covering the dress. It should be fastened with buttons, not strings, and should have no extra frills.

The matter of suitable clothing is something that can be easily controlled by the employer by the simple method of refusing to allow an employee to go to work with unsuitable clothing. In all the plants of the Steel Corporation will be found prominently posted the following notice.

WARNING

Employees working around engines, moving or revolving machinery, shafting, etc., are warned of the

and are prohibited from wearing torn clothing, loose or unbuttoned jackets, blouses, shirts, long neck ties and loose sleeves. Always wear the overall jackets tucked in the trousers or under the overall bib. Never forget to examine your clothing before commencing work.

POOR LIGHTING.

Mr john Calder in a paper read before the American Society of Mechanical Engineers, Feb. 14, 1911 gives a chart (reproduced on following page, Fig. 1.) showing the seasonable distribution for three successive years of about 700 deaths anually, due to industrial accidents reported from 80,000 plants. This chart shows that the greatest number of accidents occur during the months of minimum daylight. While the writer does not think that this increase is due entirely to the lack of light, there is no doubt that poor lighting has a considerable influence upon it. There is little doubt that the numbing effect of cold makes men less active and alert and thus increases the effect of these months. Another influencing factor (which will be discussed more in detail later) is the stupefying effect of poor ventilation which is also greatest at this season due to windows and doors being kept closed and the rather

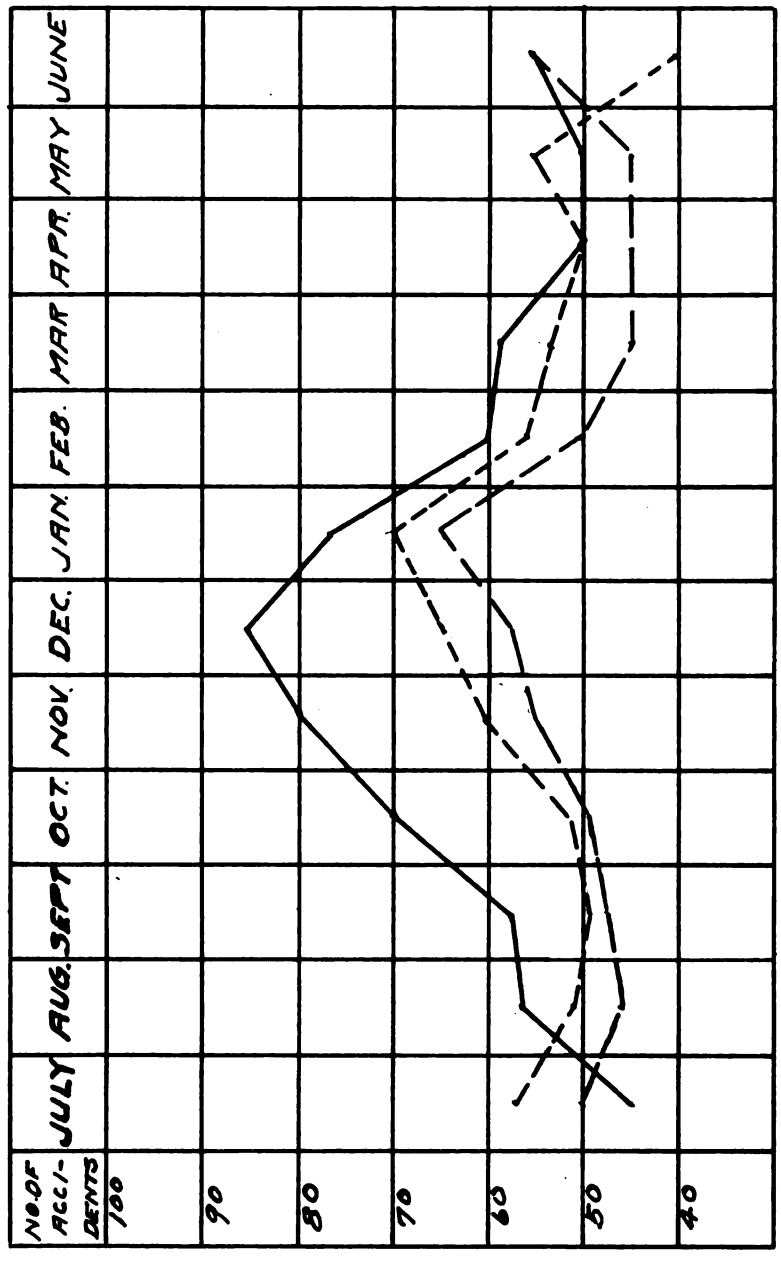


Fig. 1. Influence of daylight on the number of accidents.

Fig. 1. Influence of daylight on the number of accidents.

common use of open braziers for emergency heating.

A common system of lighting is the use of drop lights over each machine. These are often provided with a silvered reflector which throws an intense light upon the work leaving the rest of the room in partial darkness. A person working under one of these lights is unable to see at all when he first looks away thus making the liability of accidents very great. This concentrated light is usually very much stronger than daylight and thus is not only a source of danger but is also very injurious to the eyes. A more diffused system of lighting is necessary that will do away with this concentrated light and provide a light of uniform intensity throughout the room.

The subject of shop lighting is receiving a great deal of attention at the present time and conditions along this line are rapidly improving. The arc light has never been satisfactory for general shop lighting and the mercury vapor light, while efficient has the disadvantages of excessive first cost and undesirable color. The present development of the tungsten light is filling a long felt want in providing an economical light of excellant quality. The accompanying blue print (Fig. 2.) shows a lighting diagram laid out by the writer and recently installed that is very satisfactory. There are

practally no shadows, the distribution is uniform and the intensity is ample. The lights are 25 watt tungstens arranged is four light clusters and suspended by a rigid fixture about eight feet from the floor and provided with white enameled reflectors. The two outside rows are twelve feet centers, about two feet behind the operator and three feet to one side. The center bay is used for trucking and the lights are about thirty feet apart. The reason for using four 25 watt lights instead of one of 100 watt capacity was two fold. First, it makes the light less concentrated and thus secures better diffusion and second, it allows the use of 50 volt lights in series on a 200 volt circuit which is a voltage that cannot be used on the city circuits thus eliminating the temptation of the workmen to take them home.

UNCLEAN AND OBSTRUCTED WORK PLACES.

Cleniiness around a factory is of as much importance as good lighting. If dirt, waste material and tools are allowed to lie around there is always danger of a man triping or falling. The possibility of injury from this source in a room filled with machinery is very great. In some kinds of manufacturing floors must necessarily be slippery. Here unusual precautions should be taken not to leave obstructions

Fig. 2. An example ofgood shop lighting

in the way. Sand or rubber matting should be used on the floor and in some cases calked shoes are advisable. There should be places provided for all tools and equipment and they should be kept in their places. In cases where trucks etc. are used there should always be an open passageway at least three feet wide maintained the entire length of the room. The writer has seen rooms so obstructed with trucks that it was necessary to pass around among the machines and sometimes even climb over the trucks in order to get through. The danger of such a proceeding even in ordinary cases is apparent and in case of fire it becomes extremely dangerous.

DEFECTS OF MACHINERY AND STRUCTURES.

Accidents due to these causes are among the most difficult to prevent as structures will collapse and machinery will wear out and give way unexpectedly. The best safeguard is to use only the best materials and the best machines and provide frequent and rigid inspections. The safe loads on floors should be known and care should be taken to see that they are not exceeded. All parts of machines subject to rapid wear should be closely watched and repairs promptly made when required. Particular attention should be given to elevators and cranes and all structures of a temporary nature. Scaffolding should always be

inspected and tested before men are allowed to go upon it. Tools and appliances of every kind should be carefully inspected and promptly discarded when they become worn or defective. The ordinary monkey wrench is not considered a dangerous tool but many accidents have happened due to worn wrenches slipping off a nut. Overhead platforms and runways should be so constructed that tools and material cannot fall off them.

ABSENCE OF SAFETY DEVICES.

Absence of safety devices is not the most prolific cause of accidents nevertheless the method by which the employer can reduce the number of accidents in the greatest degree is by providing adequate safeguards for all dangerous operations or conditions. While many accidents can be clearly attributed to carelessness their occurance would have been impossible if proper safety devices had been in use. We must always expect men to be careless at times therefore it is the duty of the employer to provide such safety devices as will best protect the workman from the result of his carelessness.

Most machine tools can now be purchased that are all that can be desired from the standpoint of safety. The best builders have given the subject a great deal of attention. The result is not only a safe machine but a very much

better appearing one. In Figures 3 and 4 are shown two modern engine lathes in whose design every precaution is taken to guard against the accidental injury of the workmen. It would be a difficult matter for a man to injure himself in either of these machines except in the belt or the revolving work. Fig. 5. shows the same type of lathe in which no attempt is made to guard anything but the back gears and these only partially. Fig. 6 shows three designs of the same type of lathe one of which is entirely safeguarded, another only partially and the third not at all.

An inspection of these illustrations will show that in every case the properly safeguarded machine presents a better appearance and looks stronger and more sturdy than those that are unprotected. We may wonder how the makers of the unguarded machines can sell their product. The answer is that a large per cent of the purchasers are not yet alive to the importance of safeguarding, and another large per cent look at the price only when purchasing.

In Fig. 7 is shown a special boring and milling machine in which no attempt is made to safeguard the operator other than a railing to keep him from falling off the platform. Notice his location directly in front of a mass of gearing with the operating levers so located

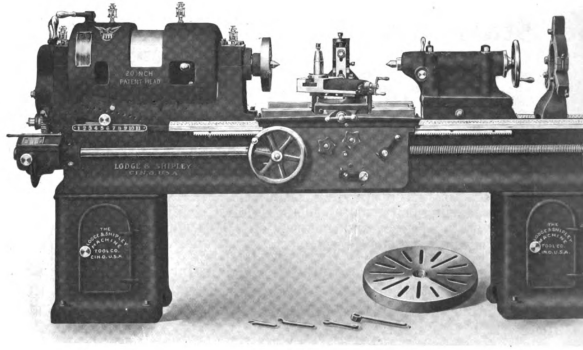


Fig. 3. An Excelland Example of a Completely Guarded Lathe.

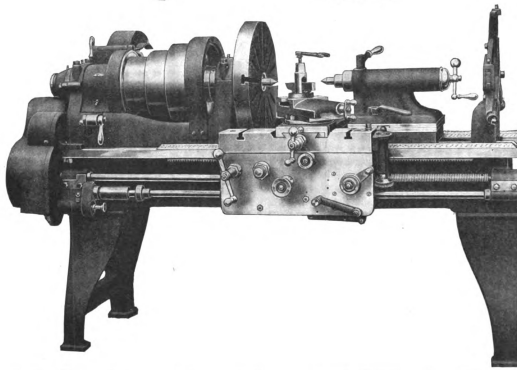


Fig. 4. A Well Guarded Lathe.

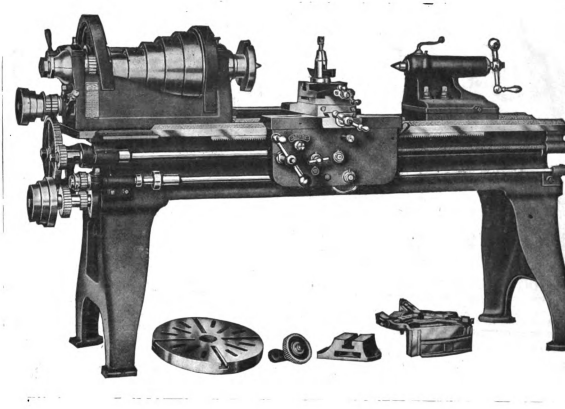


Fig. 5. Lathe Without Guards.

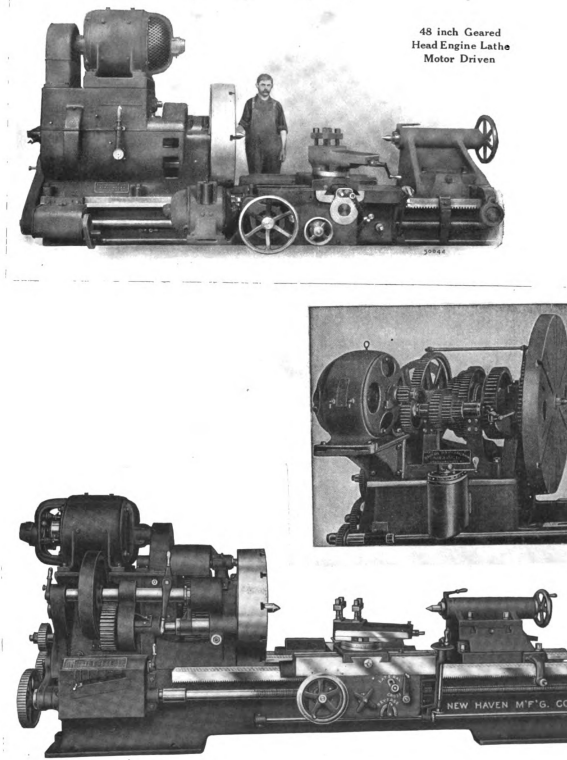


Fig. 6 Good, Bad and Indifferent.

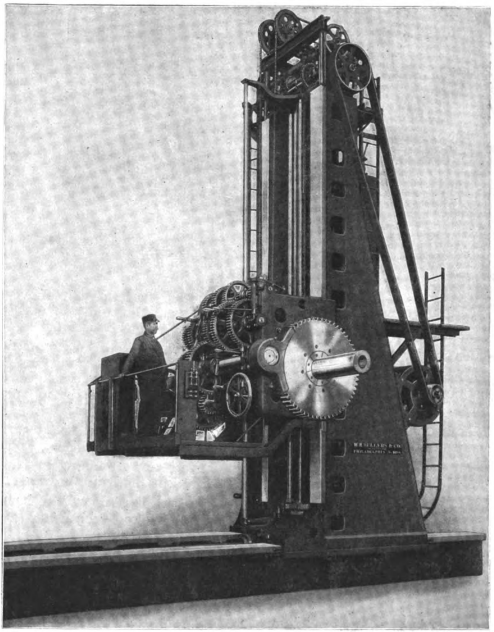


Fig. 7. A Dangerous Machine.

that he must reach over the gears to operate them. Imagine the consequences if his hand or foot should slip or his clothing become caught. It is not the builder who is responsible for the construction of dangerous machines but the purchaser. When users refuse to buy unguarded machines then no more will be built.

INSUFFICIENT ROOM AND CROWDING OF MACHINERY.

Experience has shown that accidents are far more numerous in crowded factories than in those where there is plenty of room. The reason for this is obvious. Lack of room leads to overcrowding of machinery. Thus machines are sometimes placed so close together that there is scarcely room for a man to pass between them. This condition is particularly dangerous in the case of machines having reciprocating parts or unprotected gears. The writer has seen planers placed so that the platen at the end of its travel nearly touched the wall and in one case projected through a hole in the wall fully three feet. Planers should never be so placed that a man can be crushed between the platen and adjoining structures. If it is necessary to so place them the space should be railed off so a man cannot pass through there. There should be not less than three feet free space between all machines having exposed moving parts. Even where

machines are guarded in the fullest measure it is rarely possible to eliminate all danger so this rule should hold in nearly all cases. Space should never be considered of more value than safety.

POOR VENTILATION.

Anything that has a stupefying effect upon a workman or lowers his vitality increases the liability of accidents. Foul or impure air laden with dust, dirt, smoke, oil fumes, etc. has this effect in a very marked degree. It not only increases the liability of accidents but soon injures the health of the workman. This is especially true in grinding and buffing operations particularly on brass where the dust entering the lungs has a tendency to cause consumption. In this particular class of work the installation of an efficient dust collecting system which will thoroughly remove the dust will usually be found to be a paying investment financially. In one grind shop the writer has in mind the wages paid for unskilled labor in this department average higher than that paid for skilled labor in the other departments. This is because men cannot stand to work in there but a shorttime and it is only by paying exceptional wages that they can be secured at all. A dust colletcing and separating system is now being installed and it is expected

that when the installation is completed wages can be reduced from 25 to 30 per cent.

OVERWORK.

The effect of overwork is very similar to that due to poor ventilation. The men become tired and listless, their movements become slow and their minds wander from their work. This effect is particularly noticeable in men engaged in work of a monotenous nature, like punch press work. It is quite common practice in many lines of manufacture to work overtime during the rush season, often working twelve hours a day for weeks at a time. This does not leave a man sufficient time for rest and recreation. He comes to work in the morning tired and inactive and his movements become more sluggish as the day progresses. The result is a gradual decline of both the quantity and quality of his work and enormously increases his liability to accidents.

INTOXICANTS.

The use of intoxicants should be absolutely prohibited during working hours and a man who habitually uses liquor to excess should not be tolerated. A man returning from a prolonged spree with his nerves in a shaky and weakened condition is as dangerous as one actually under

the influence of liquor. No person even slightly intoxicated should ever be allowed inside the works, he endangers not only himself but others. The attitude of the Steel Corporation on this subject is expressed in the following rule: " Any person coming to work under the influence of liquor will be discharged."

SET SCREWS

The set screw is a small thing but it has probably been responsible for more serious accidents than any one thing connected with the operation of machinery. It projects beyond the face of the collar, sometimes an unnecessary amount, revolves rapidly with the shaft, has sharp square edges and readily becomes entangled with any soft material with which it comes in contact. When a man's clothes come in contact with a set screw, unless the cloth tears out immediately, he is quickly picked up and whirled rapidly around the shaft. The result is a serious or fatal injury.' The only way to avoid this risk is to either eliminate or guard all projecting set screws. No matter how remote its location, a protruding set screw on a revolving shaft is a source of danger. Many accidents have happened from set screws located in what were supposed to be inaccessible places.

The standard square head set screw has many advantages which make its use preferable to other types. They may be used with perfect safety in properly designed collars. Fig. 8. shows the best type of safety set collar for general use. The screw should be of the proper length so its head will not project beyond the flanges. Also note the cross bridges extending from flange to flange on each side of the set screw.

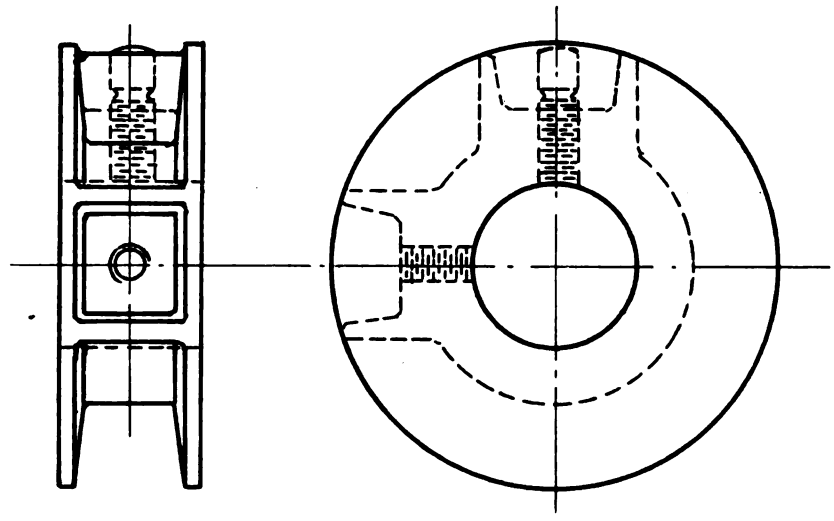


Fig. 8.

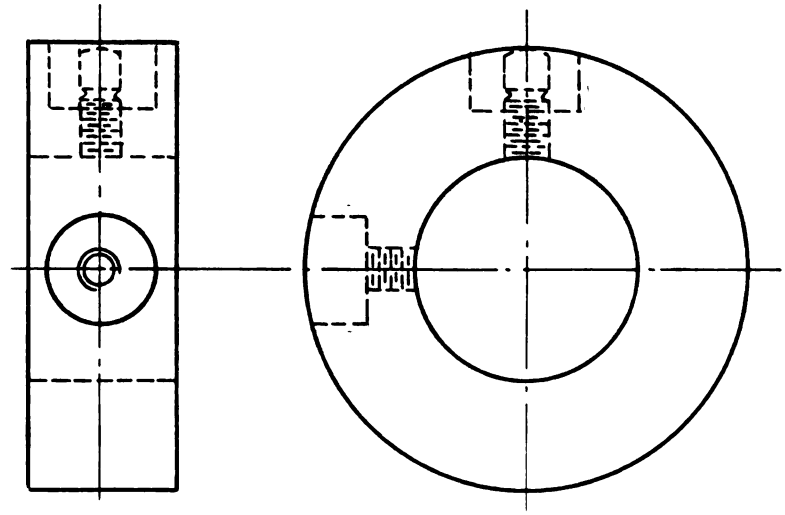


Fig. 9.

Fig. 8.

Fig. 9.

These are important as theflanges alone do not offer sufficient protection although many safety collars are made in that way. Fig. 9. shows a type equally as desireable as Fig. 8. although not as cheap. It is used where a finished surface is desired for appearance or where the material used is steel. The counterbore may be made of sufficient diameter so an ordinary wrench may be used or it may be made smaller and a box key provided.

The headless type of set screw, made to tighten with a screw driver, is sometimes used although this is not a very desireable type as the slot quickly wears out and it is not possible to exert sufficient force with a screw driver to tighten them properly.

Two very desirable and absolutely safe types are shown in Fig's. 10 & 11. The first is sold by Hammacher Schlemmer & Co., New York City and the other by the Allen Mfg. Co., Hartford, Conn. The screw is made short so it will not project beyond the face of the collar and the key is inserted nearly the full length so there is no tortional strain and nearly the whole force is applied at the point where it is required. Thus they may be tightened much tighter than the ordinary type. They have one serious objection however and that is they require a special key of a different size for each size set screw.

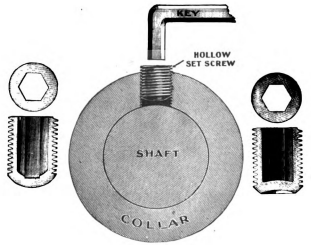


Fig. 10. (Patented)

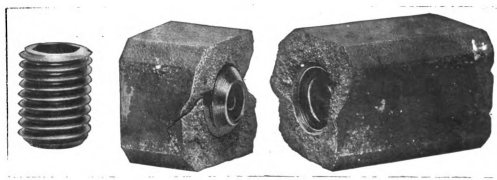


Fig. 11 (Patented)

In cases where it is desired to retain the old type of set screw without a safety collar some of the following forms of protective devices may be used. Fig. 12. shows a protector manufactured by the H. O. Canfield Co., Bridgeport, Conn. It is made of rubber and is forced on over the head of the set screw and is easily removeable. Fig. 13. shows a steel guard which springs on over the collar. In Fig. 14 a piece of old belting is drawn around as shown and tightly laced. Another way of using belting is to wind it around the collar allowing the set screw to project through a hole in each turn until the belting is flush with the head of the screw when it is securely fastened. Fig. 15. shows a wooden guard ring that is cheap, thoroughly effective and presents a smooth neat appearance.

In addition to the above there are collars that require no set screws but are held in place by friction. They are rather expensive and not very generally used and owing to their method of clamping are not adapted to all classes of work. There is an open field for a simple, cheap and effective clamp collar.

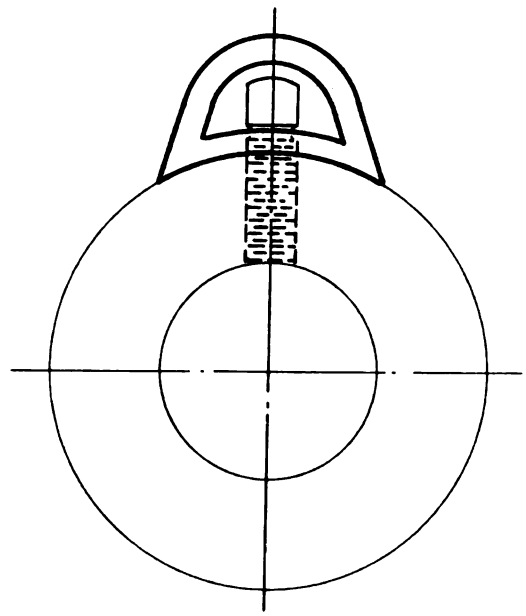


Fig. 12. (Patented)

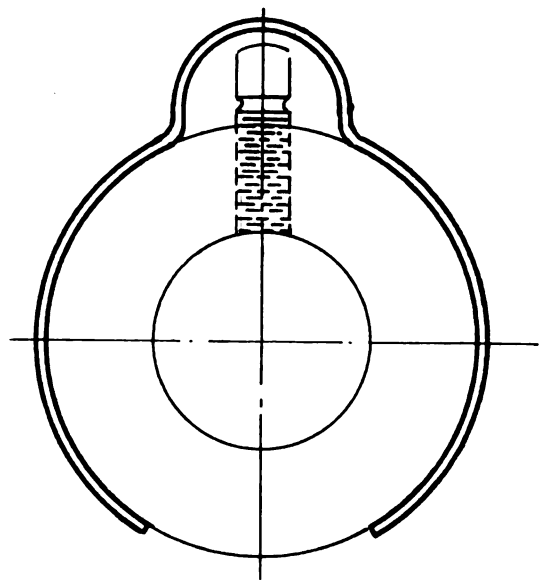


Fig. 13.

Fig. 12. (Patented)

Fig. 13.

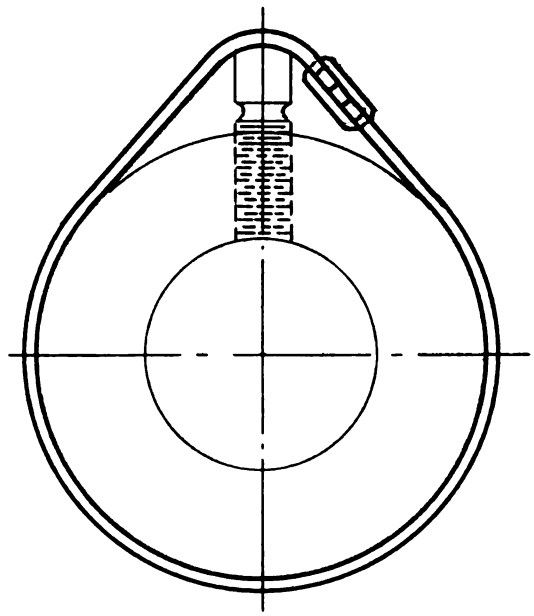


Fig. 14.

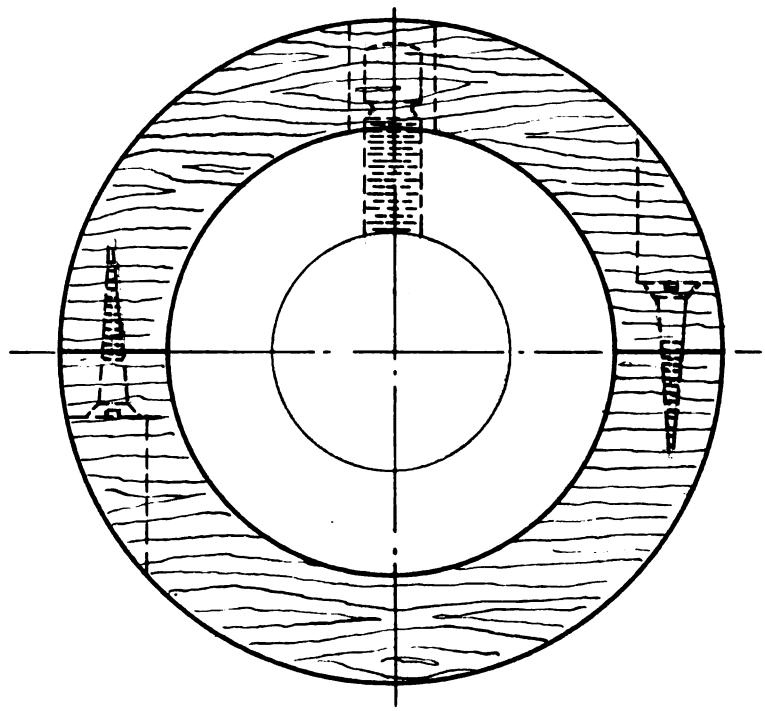


Fig. 15.

FIG. 14.

FIG. 15.

SHAFT COUPLINGS.

What has been said concerning set screws applies with equal force to projecting bolts in couplings. No projecting bolts or set screws should be allowed in any coupling. In the following illustrations some of the most approved types of safety couplings are shown.

In Fig. 16. we have the most common form of safety coupling, the rim flange coupling. The only precaution necessary in using this type is to see that the guard rims are of ample depth to completely protect the bolt heads and that the keys are not allowed to project beyond the hub.

The plain sleeve coupling as shown in Fig. 17. is cheap and sufficiently good for many classes of work. When it is used the set screw heads should be set into a counterbore or protected by ribs in a similar manner to the collar in Fig. 8. When made in this way they are called rib couplings. They may also be split in which case they are called split muff couplings. An improved form of this type of coupling known as the "grim death" is shown in Fig. 18. This makes a safe, comparatively cheap and very strong coupling. It is usually bored slightly smaller than the shaft and when drawn together by the bolts grips the shaft ends with great force, hence the name. It also insures perfect alignment of the shafting, an

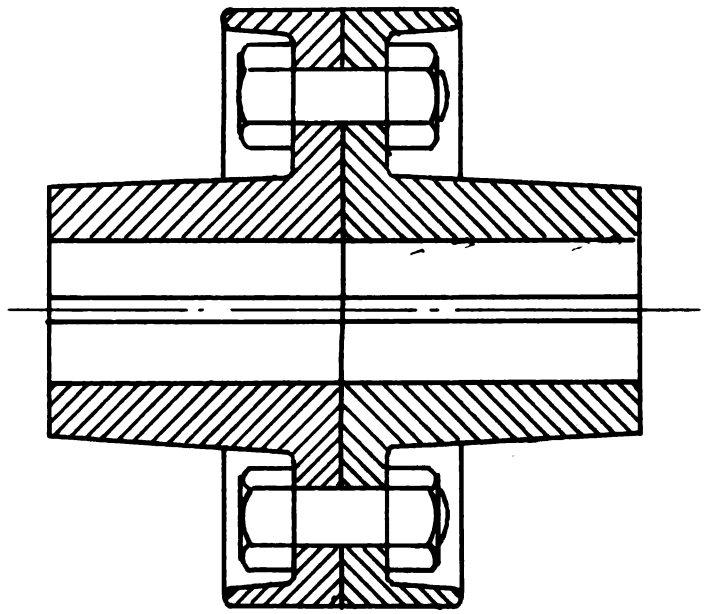


Fig. 16.

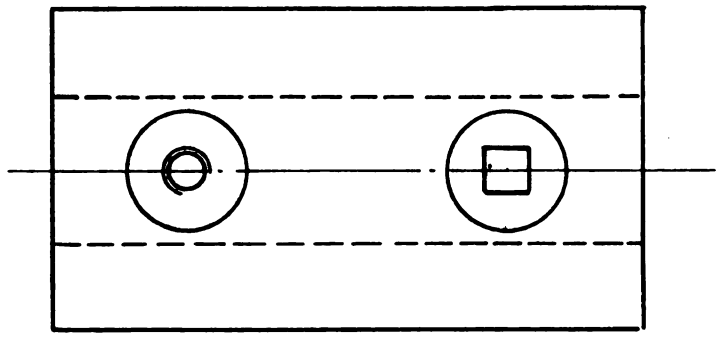


Fig. 17.

Fig. 16.

Fig. 17.

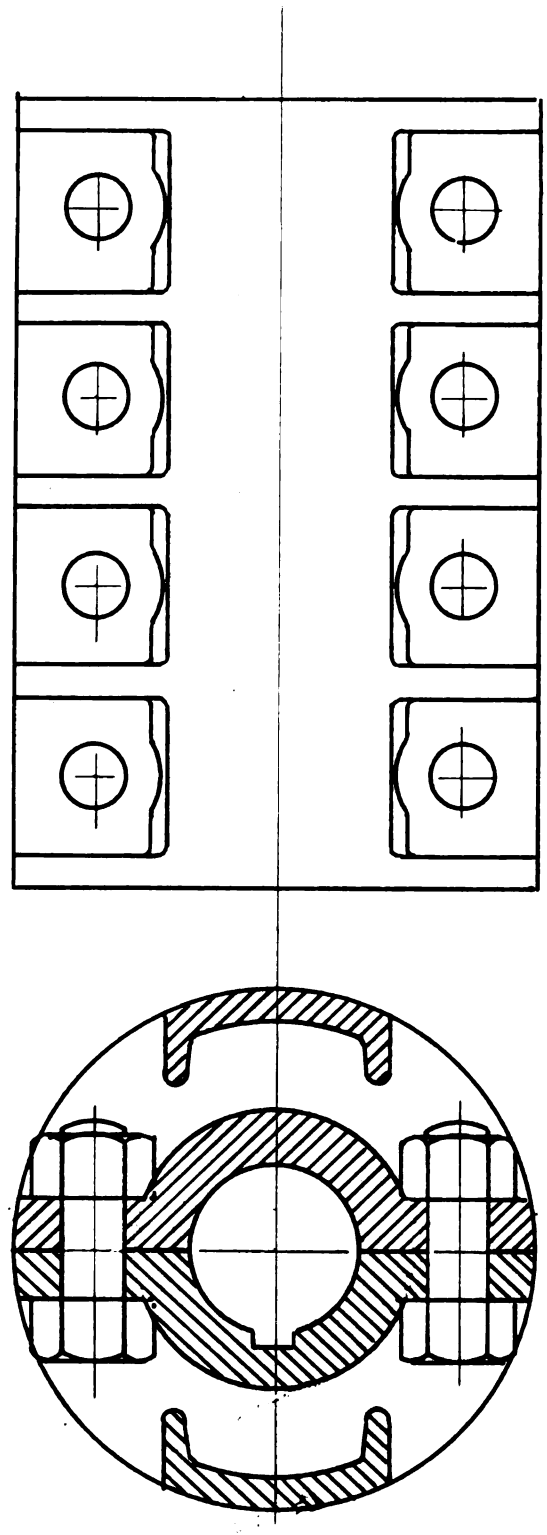


Fig. 18.

Fig. 16.

important feature.

In Fig. 19. we have probably the best form of safety compression coupling on the market. As will be seen from the sketch it consists of a tapered, split bushing threaded at each end. The tapered portion is clamped by two taper bored rings which are forced on by the spanner nuts as shown. This is known as the Collins coupling. When in position on the shaft it presents an absolutely smoothe surface with no projections whatever.

In Fig. 20. we have a modification of the same type with the nuts omitted. The bushing is clamped by two wrought iron rings driven on. In both these types the bushing is usually bored slightly smaller than the shaft thus securing the clamping and self aligning feature. While it is customary to use a key with these couplings it is not absolutely necessary except in very heavy work although it is disirable as a precautionary measure.

There are other forms of safety couplings on the market but they are nearly all based on the principles of the above, are more expensive and give no better results.

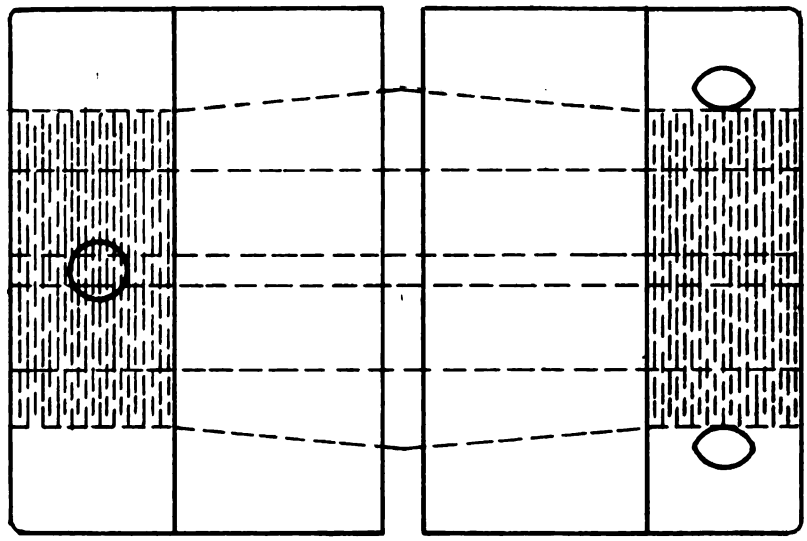


Fig. 19.

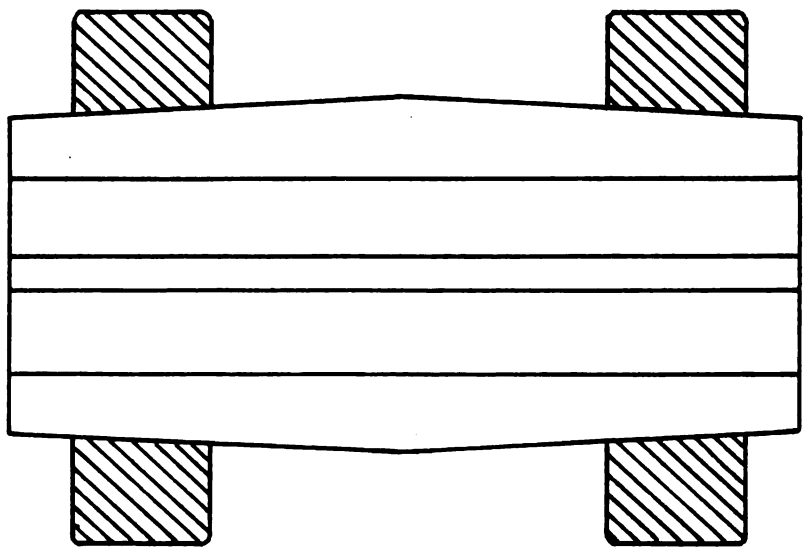


Fig. 20.

Fig. 19.

Fig. 20.

GEARS.

There are few machines that do not in some manner employ gears. This gearing, no matter what its nature, if unguarded is dangerous. Gears are frequently so situated that they are a constant menance to the operator. they are always a source of danger when cleaning or oiling and are in many cases in close proximity to a passage way through which men are constantly passing. They are usually driven with great power and frequently at high speeds and their very nature makes them particularly liable to catch anything coming in contact with them. If a man's sleeve is caught his arm is invariably drawn after it and only in rare instances does he escape serious injury. There is one feature however that keeps down the number of gear accidents and that is that gears are easily seen, their danger is generally recognized and men working around them are usually carefull. Therefore the number of accidents resulting from gears are far less than those resulting from other parts which, in themselves, are much less dangerous. Nevertheless the fact remains that gearing is extremely dangerous and should in all cases be effectually guarded.

Most builders of high grade machinery now guard their gearing but in cases where it is not guarded or in the case of old machinery it is necessary for the owner to provide suitable guards.

In the following illustrations some typical forms of gear guards are shown. These are all practical and easily constructed and each represents some form the writer has either designed himself or observed in actual use. One thing must always be kept in mind in designing gear guards and that is, to be efficient they must be STRONG and RIGID and COMPLETELY ENCLOSE THE GEAR.

The blue prints, Fig's. 21 and 22 show the general arrangement and details of a spur and worm gear drive recently designed by the writer. Here we have the most efficient form of gear guard it is possible to produce. The gears are completely enclosed and the guards are so designed that they are a part of the bearing, thus making it impossible for the operator to remove them or in any way tamper with the gears while the machine is in operation. In other words, without the guards the machine is inoperative.

This ideal condition can frequently be attained in the design of new machines but not often when applying guards to old machines. In Fig. 23 we have a cast iron guard for a pair of bevel gears. As will be noted it is cast in one piece and may be lowered in place from above. It covers the gears completely including the shaft ends and keys and may be held in position by lugs cast on the guard in such a manner as to rest on the bearing cap or preferably some portion of the

FIG - 21.

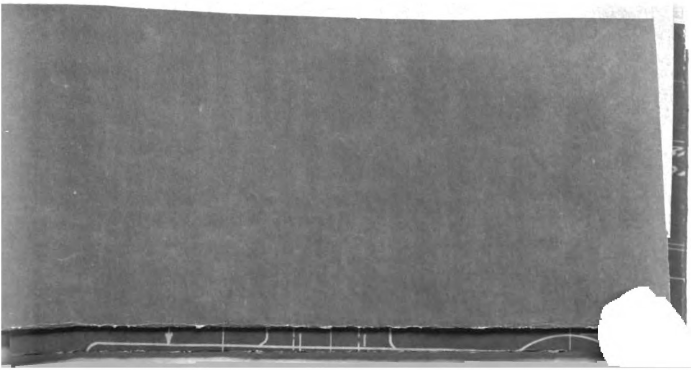
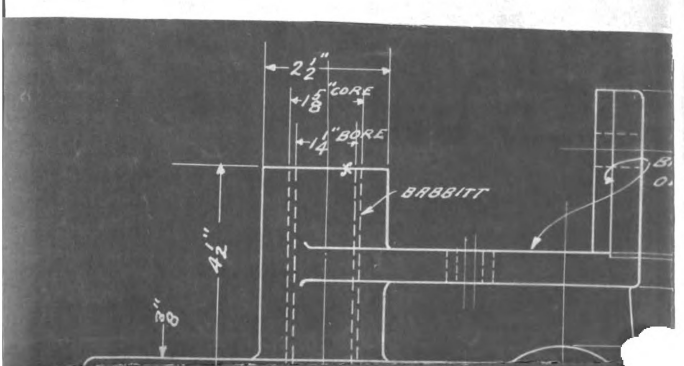


FIG. 22.

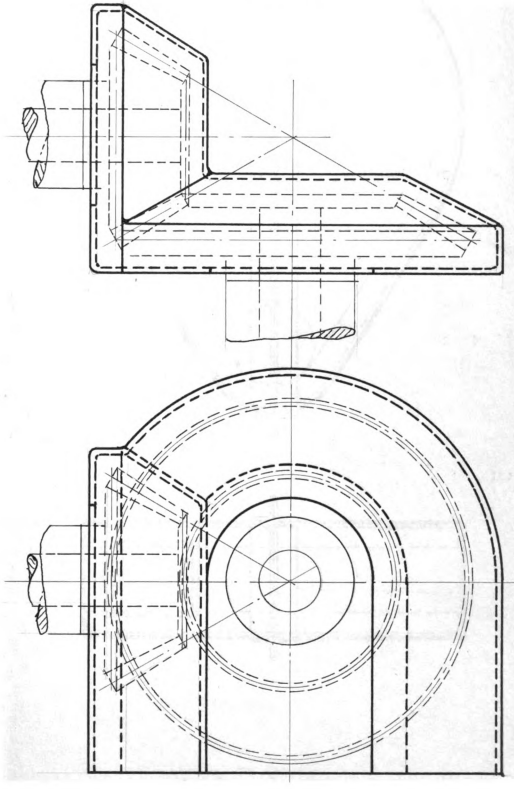


machine frame. The pattern work may be symplified by making the guard of plain rectangular cross section or carrying it straight across between the outside faces of the gears instead of forming it to suit the contour as shown. The same idea can of course be applied to spur gears, sprockets, etc.

While the cast iron guard is probably the cheapest form for the machine builder to use, the cost of pattern work makes it more expensive than a steel one when only one is wanted. In Fig. 24 is shown a spur gear and pinion guard of steel. It is shown with one side closed to protect the ends of the shafts but may be used on gears located between bearings by simply cutting the hole for the shafts through both ends. Fig. 25 shows the same idea arranged to set on the floor when the gears are so located as to make this desirable. These are the standard forms of guards used by the United States Steel Corporation at the Gary mills. The angles are 1 1/2 x 1 1/2 x 3/16 and the plate #12 gauge. A hinged door is provided on the top for oiling and inspection. This is undoubtedly the best form of guard for general mill use. It is strong, neat and efficient.

In Fig's. 26 and 27 are shown two types of guards that are frequently used but are not to be recommended. They are illustrated for the purpose of pointing out their defects and warning against their use. The first, if the gears mesh

Fig. 23.



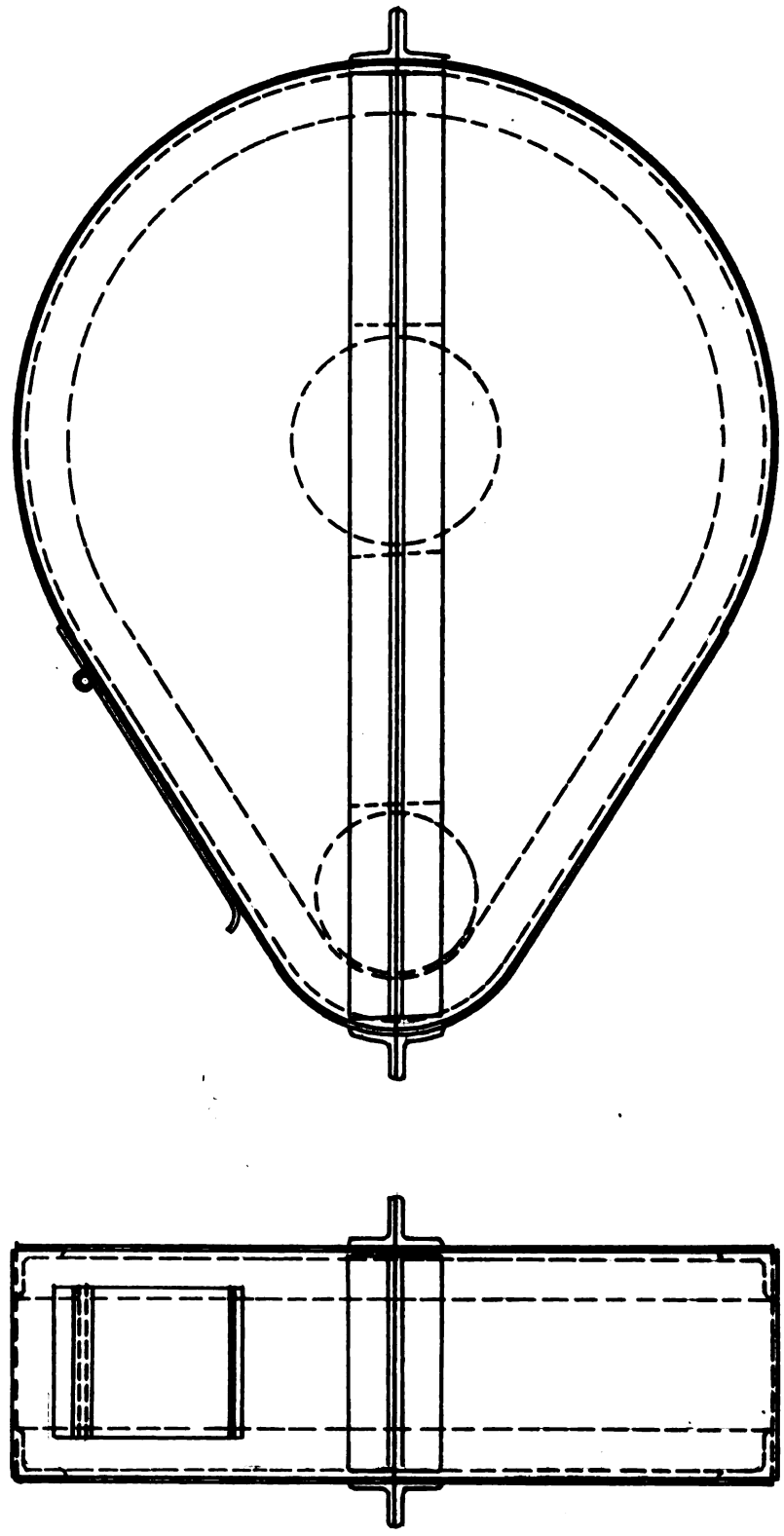


Fig. 24.

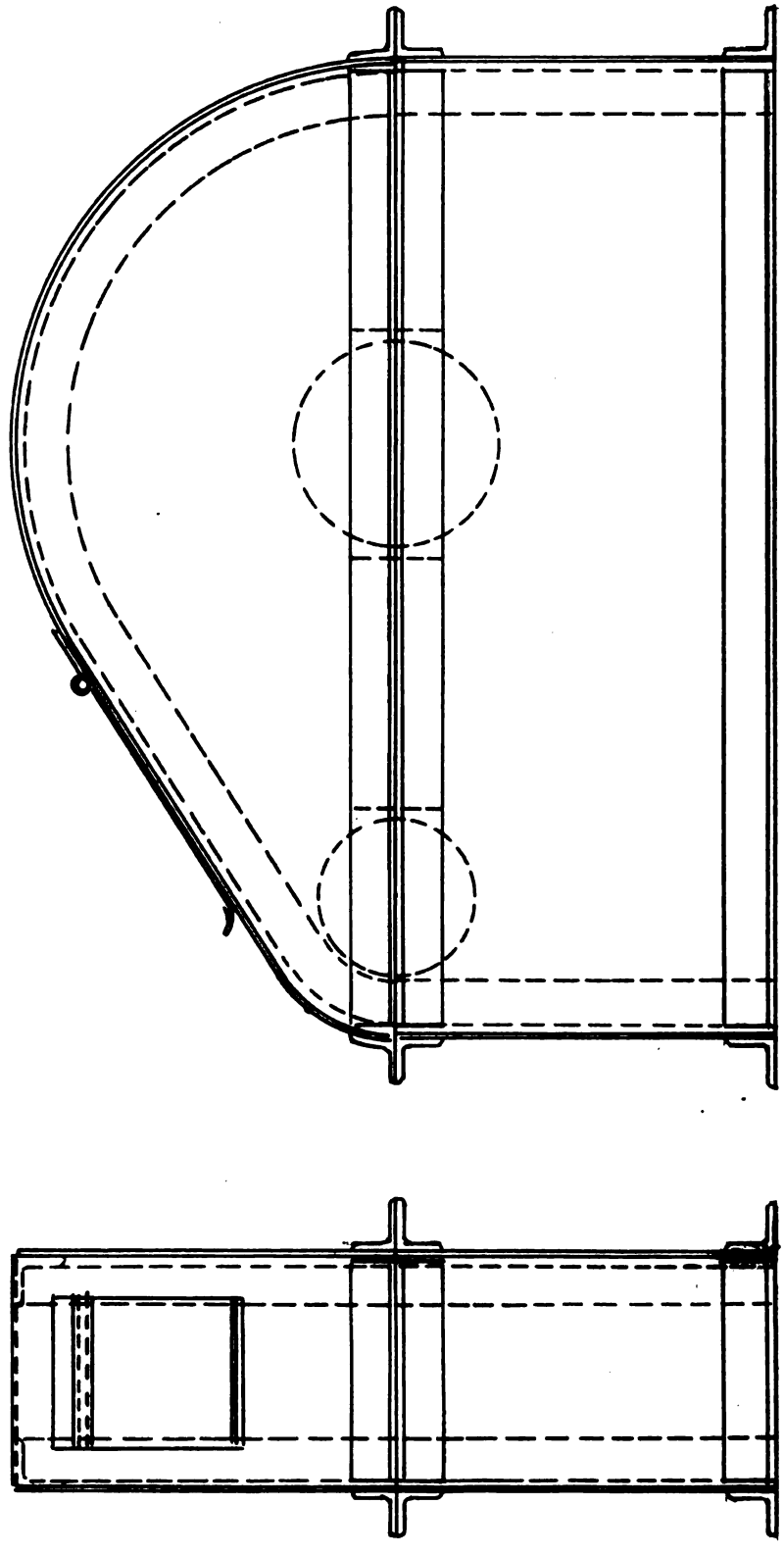


Fig. 25.

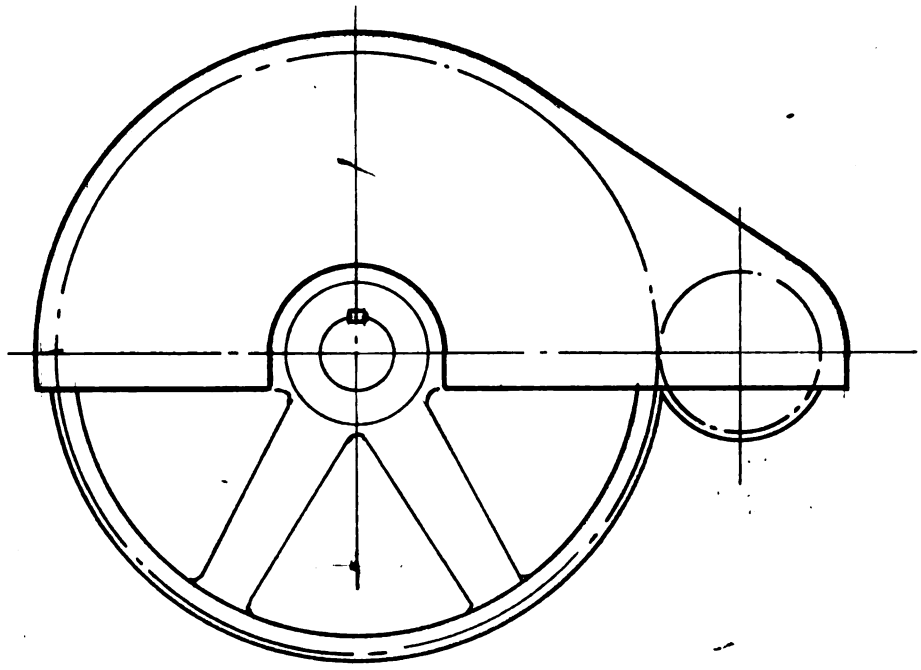


Fig. 26.

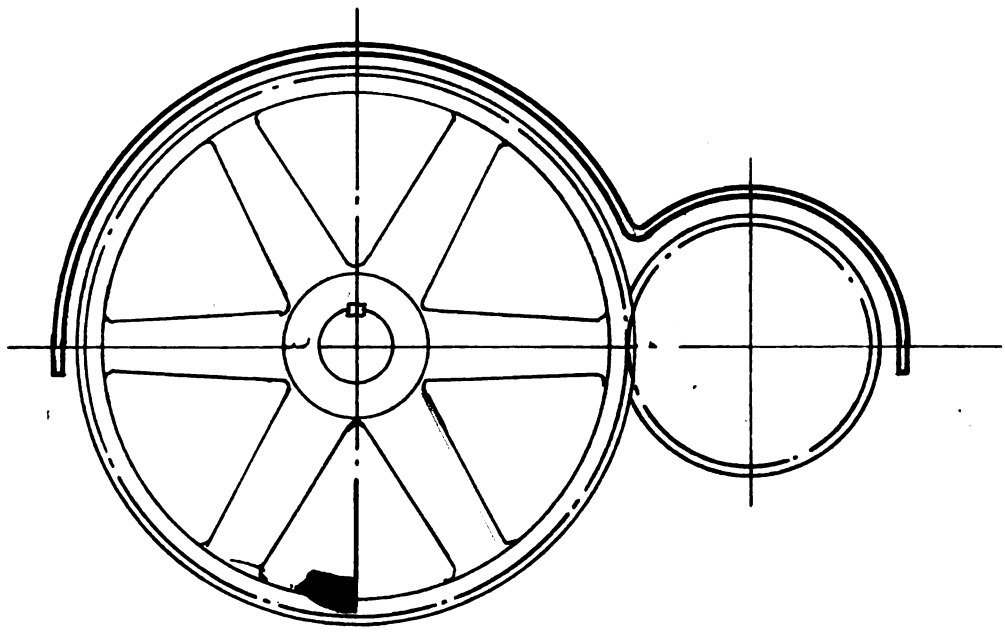


Fig. 27

from the top, offers a fair measure of protection but it does not protect the end of the shaft and it leaves open the possibility of a man's getting caught between the teeth and the guard on the outside edge. In çase the gears mesh from the bottom it offers but little protection, in fact it makes the probability of serious injury greater in case a man is caught. The writer knows of a guard constructed exactly like this in use at the present time. The gears mesh from the bottom and the guard is cut out as shown exposing the the end of the shaft and its projecting key. There is no apparent reason for cutting it out in this way, it is simply a case of careless and thoughtless design.

The second form is open to all the objections of the first and in addition it does not even afford protection against being caught between the gears when they mesh from the top. Both forms are thoroughly bad and should be avoided in all cases.

Fig. 28 shows a punch press equipped with a guard similar to that shown in Fig. 24 except that the sides are made of wire netting about #12 gauge and 1/2 inch mesh. This is not as strong as a guard with plate sides but in places where it cannot be used as a step ladder is strong enough and has the advantage that the gears are visible and can be readily inspected. The lower half of the fly wheel is shown guarded in the same manner.

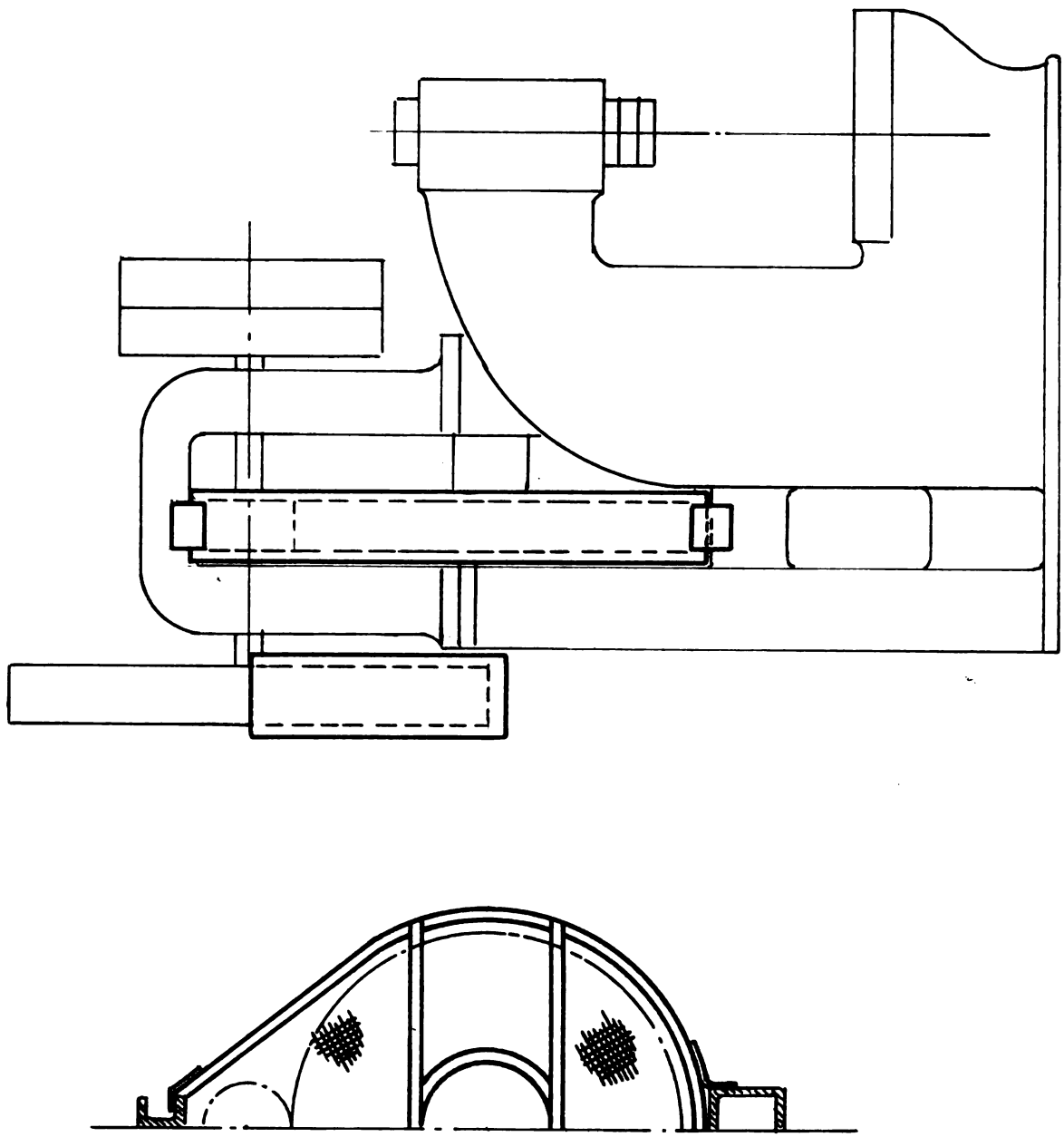


Fig. 28.

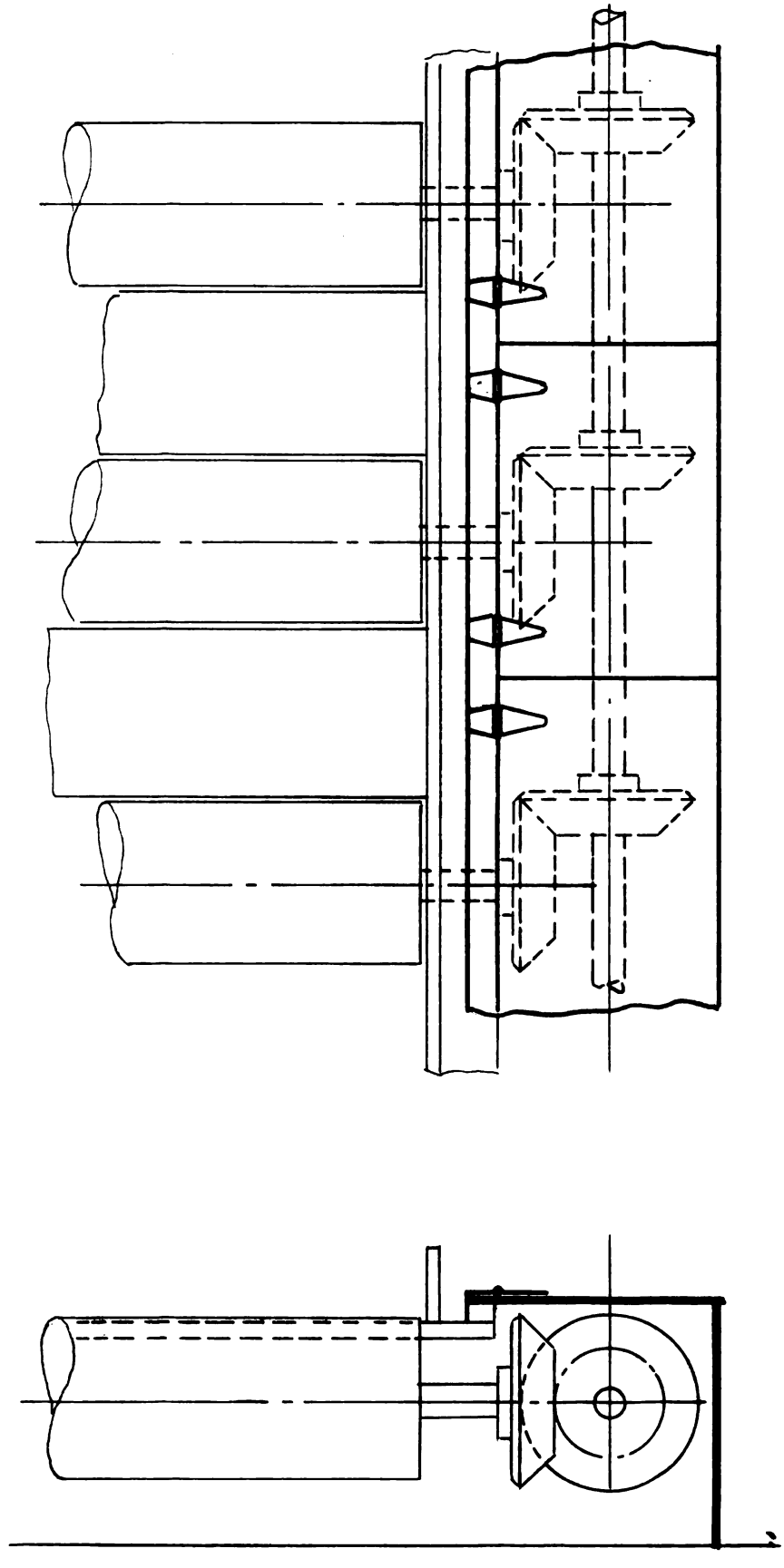


Fig. 29.

In Fig. 29 is shown the method of guarding live roll gears in the steel mills. The top plates are hinged and are made sufficiently strong so they may be used to step on in crossing the roll table. Frequently gears in a manufacturing plant can be boxed in in a similar manner to advantage.

Fig. 30 shows about the neatest form of guard for the change gears on a lathe or any gearing exposed in a similar manner. It consists of a steel frame covered with wire netting. It is fastened to the floor and the machine by means of clips or hooks in such a manner as to be easily removable. A steel plate reinforced with angle iron or even a wood box is equally as efficient but do not present as neat an appearance.

Fig. 31 shows a method of guarding bulldozers used in a local shop. The machines are arranged along the wall and wood partitions are built out each side thue effectually protecting them. The partitions are arranged so they can be readily removed when it is necessary to make repairs.

In some types of machines, like heavy milling machines, there are a series of reducing gears placed on the floor or in a pit at the side of the machine. These can be boxed in completely by steel plate or wood boxes or they may be enclosed by a pipe or angle iron railing such as are shown later under the head of Stairways, Platforms and Railings.

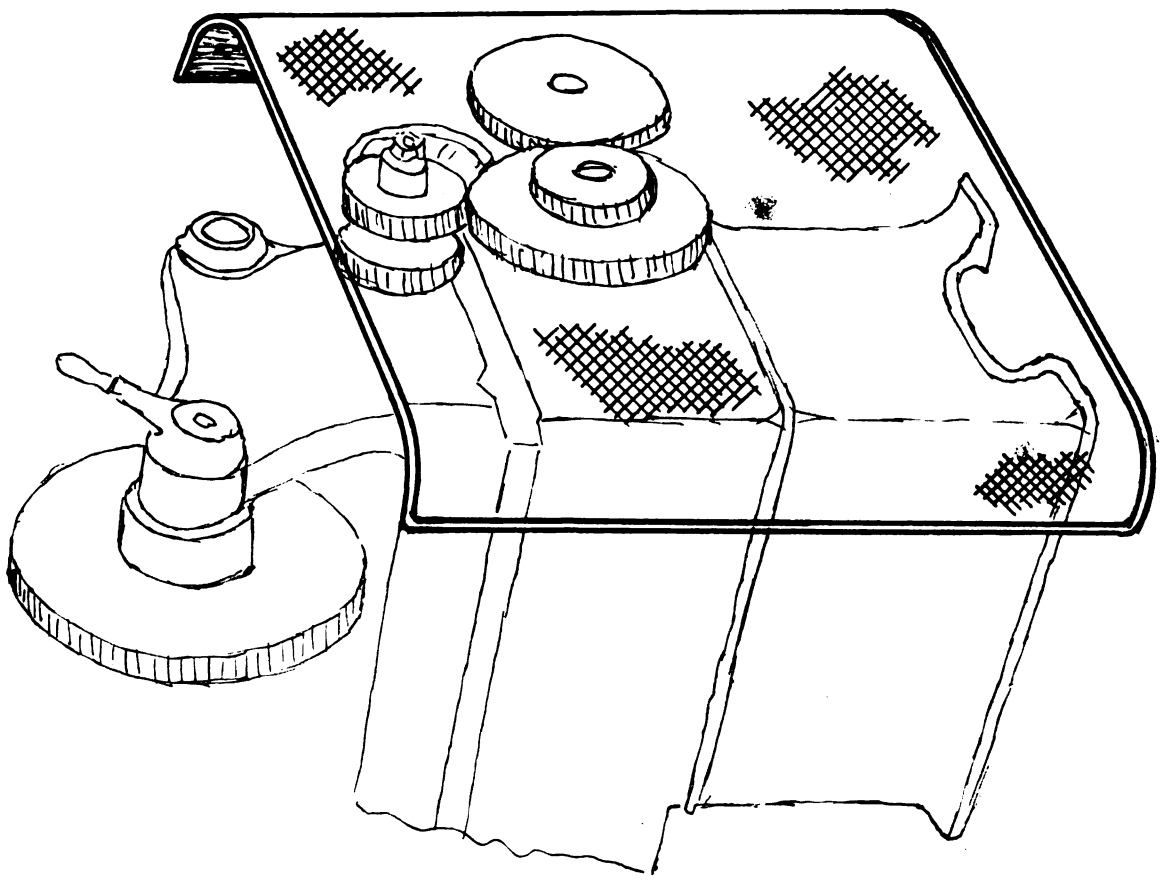


Fig. 30.

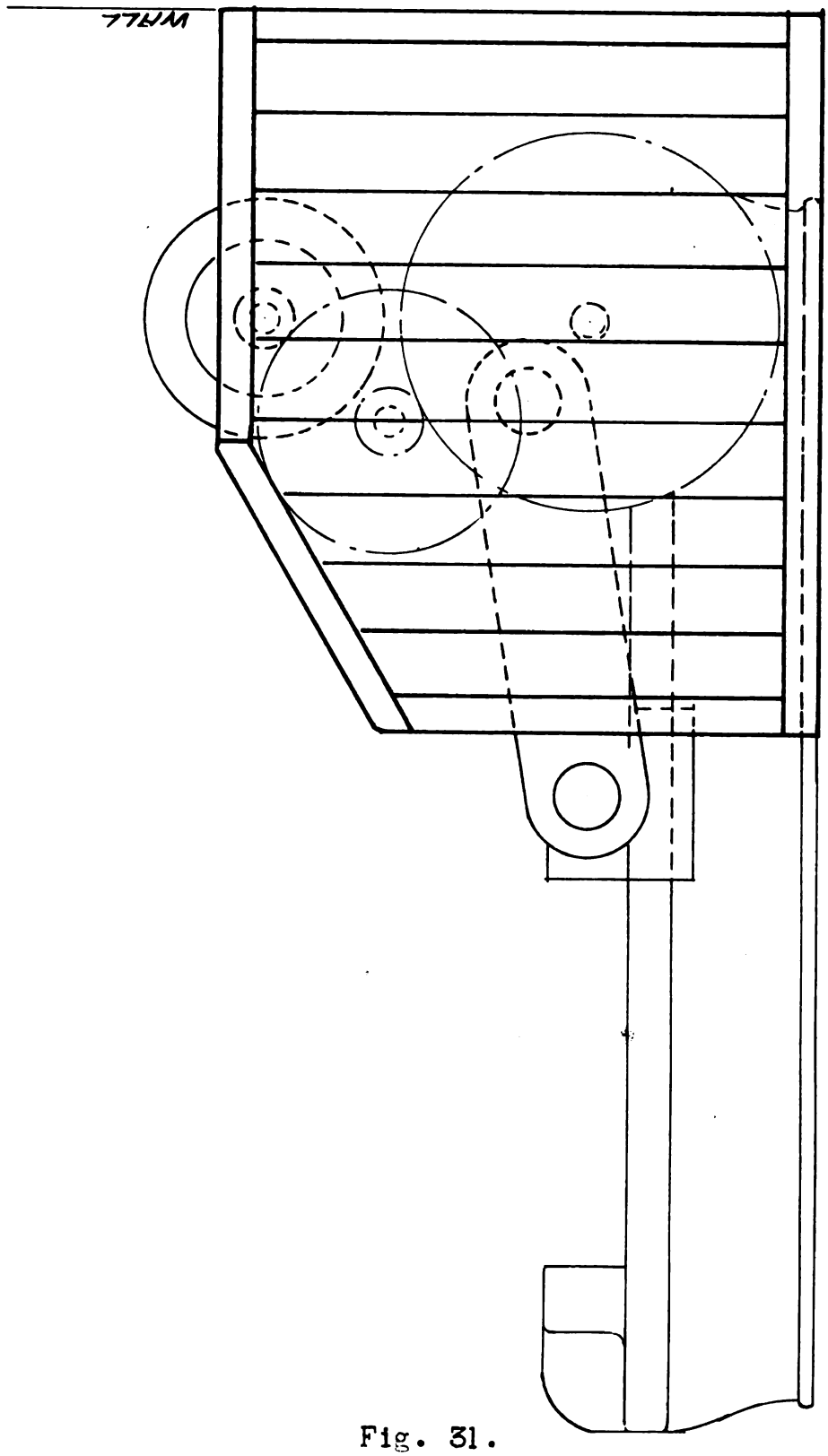


Fig. 31.

FLY WHEELS, BELTS AND PULLEYS.

Fly wheels, belts and pulleys are danger points against which ample protection can be secured with but little trouble and expense. They are probably the most easily guarded of any part of a machine or plant. Fly wheels are always more or less dangerous and should be guarded in all cases as far as it is possible to guard them. One of the most serious and disasterous accidents that can happen about a plant is a fly wheel explosion and this is something that cannot be effectively guarded against. The most that can be done is to exercise care in seeing that all fly wheels are well balanced, that they run at a safe speed, that they show no defects in material and that the engines are provided with automatic safety stops to prevent racing.

Probably the most effective method of preventing injury by contact with a fly wheel is to build a pipe or angle iron railing around it. This should be at least three feet six inches high and not closer than eighteen inches to the wheel at any point. Fig. 32. shows such a railing protecting a large belt wheel and belt. When the wheel runs in a pit as shown there should be provided a toe board not less than six inches high to prevent anything from being kicked or knocked into the pit. A wrench or any similar object falling into the spokes of a rapidly revolving fly wheel will

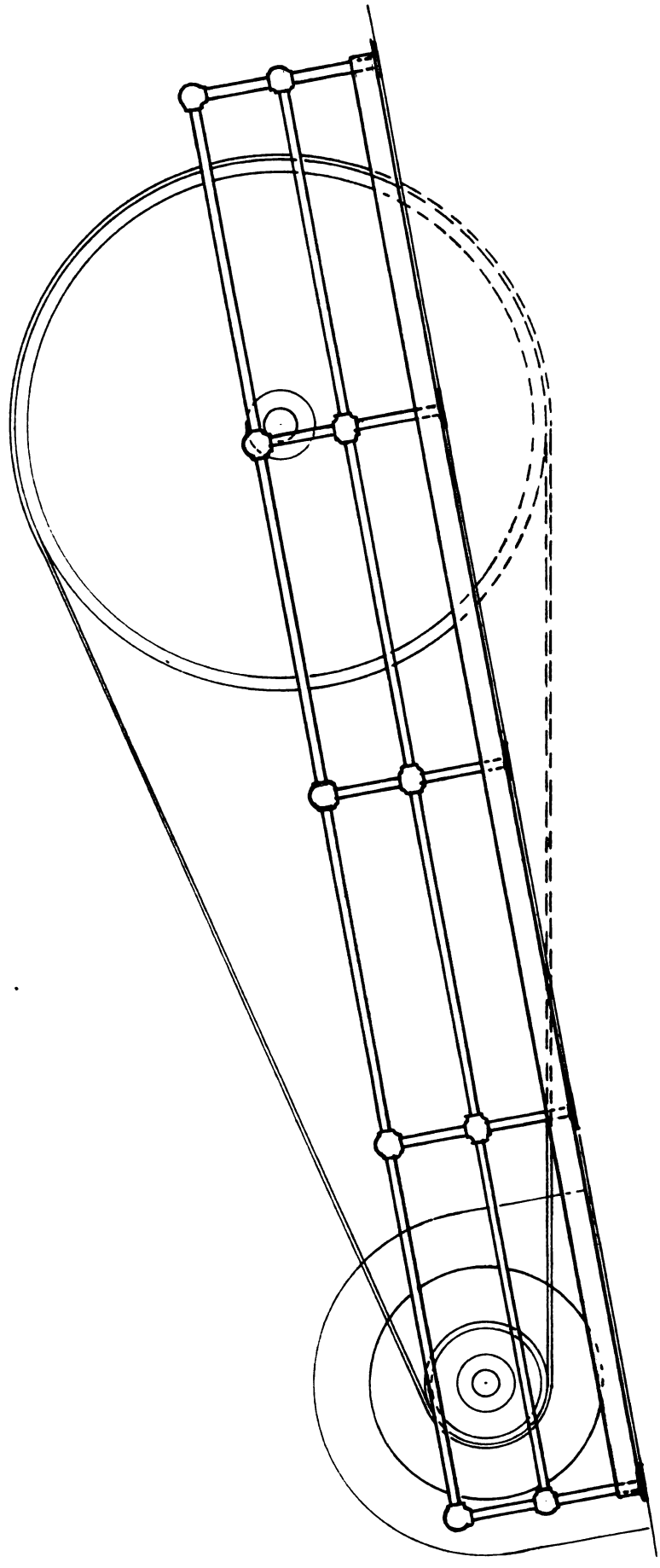


Fig. 32.

often be thrown with great force. Belts running close to the floor in this way should be fenced in to prevent men from stepping through them, a practice that is quite common and extremely dangerous. In cases where a fly wheel or large pulley can be guarded in no other way the arms should be protected by a sheet iron disk firmly secured to them.

When a belt runs horrizontally and sufficiently low to come in contact with a man's head it can be protected by a guard similar to that shown in Fig. 33. The sketch shows a wood slat construction but metac can of course be used if desired. An angle iron frame covered with wire screen is the neatest form of guard for this class of work but the expense is hardly justified in most cases.

Belts passing through floors are highly dangerous as there is always more or less windage created by the rapidly moving belt tending to attract the clothing of a person passing near. A person caught between a belt and an opening in the floor is sure to be badly cut and possibly even dragged through the opening. Such belts may be easily guarded by boxing in as shown in Fig. 34. In case the driven pulley is near the floor as shown in Fig. 35. there is the additional danger of being caught between the belt and pulley. Such cases should be completely boxed in as shown or railed off.

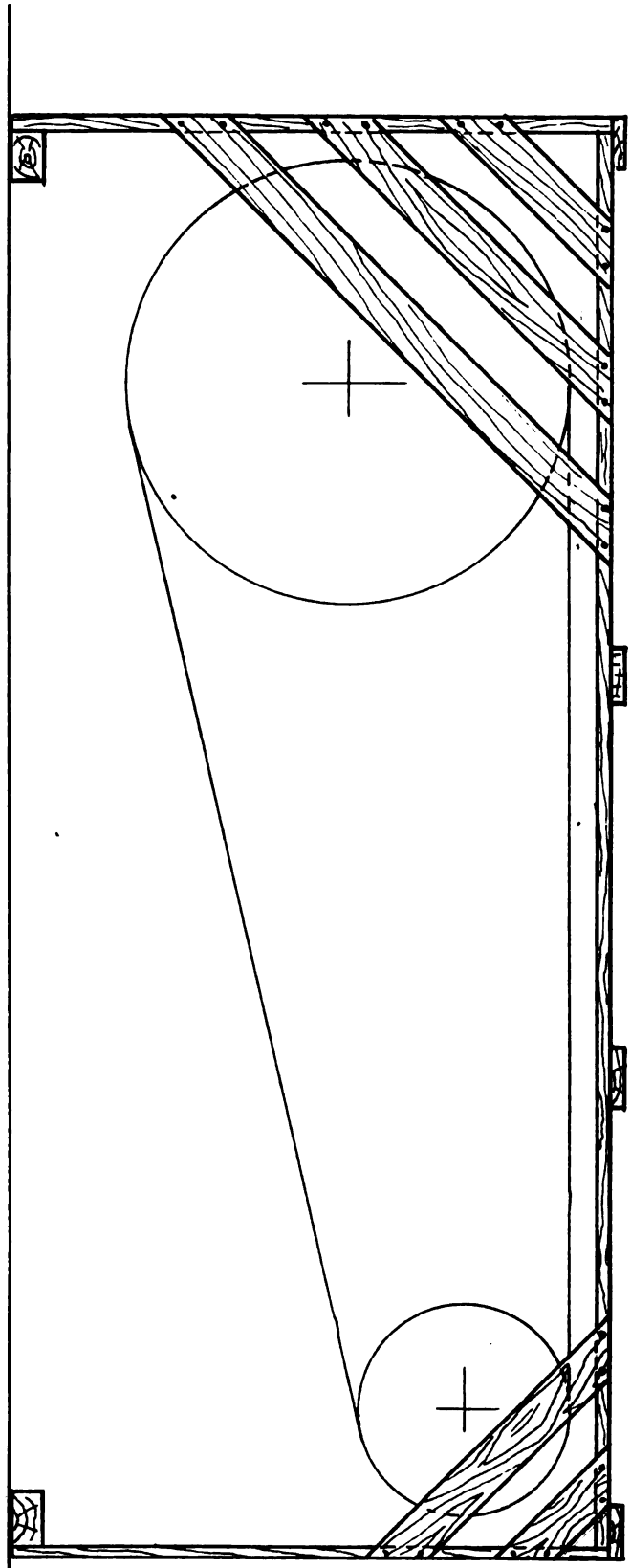


Fig. 33.

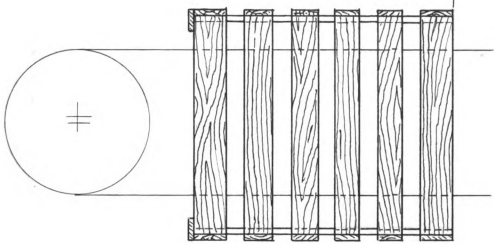


Fig. 34.

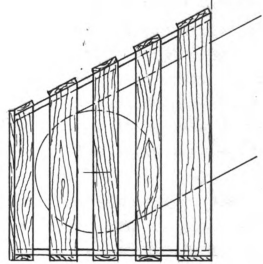


Fig. 35.

In many cases countershafts or motors are placed on the floor. These should always be railed off. In many plants it is made an inflexible rule that all motors shall be placed on the ceiling or a platform. This is an excellent practice as it not only elliminates the danger but saves floor space as well.

While light belting such as is used on lathes and drill presses is not particularly dangerous under ordinary circumstances, there are conditions under which they should be guarded. If a drill press is backed up close to a passage way a guard of some kind should be provided. A railing or wire screen guard about three feet six inches high is usually sufficient except in cases where female help is employed. In this case such belting should be thoroughly and completely guarded as shown in Fig. 36. The character of a womans clothing and the great liability of her hair being attracted by the belt makes it necessary to take unusual precautions. The guard should extend to a height of not less than six feet. It is also necessary where female operators are employed on drill presses to carefully guard, not only the spindle gears but the spindle itself as there is great danger of the hair becoming entangled in it.

The hand shifting of belts on cone pulleys on lathes, drill presses and similar machines is

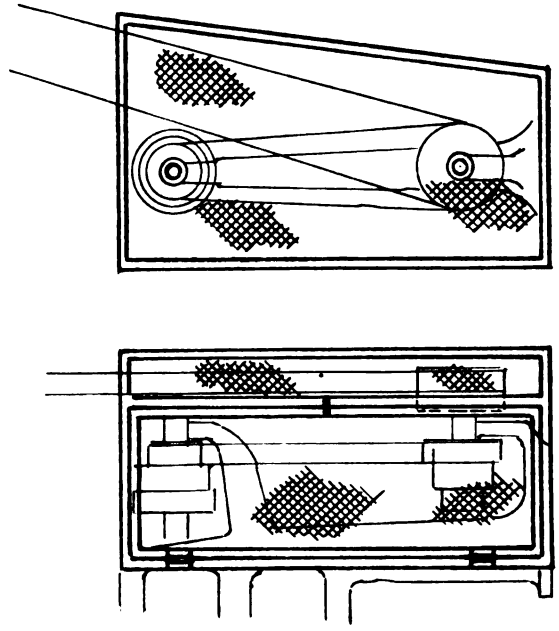


Fig. 36.

responsible for many injuries, the hand being caught and carried around the pulley. It is as easy to shift the belt with a short stick a wrench handle or similar article as by hand and this should be insisted upon. It is common practice in many shops to use the hand in picking up a belt from a shaft or rest and placing it upon a pulley. This is a particularly dangerous practice that should never be premitted. The danger is due, not only to the belt and pulley, gut to the fact that a man often climbs upon a box, barrel, step ladder or other unstable support which is apt to slip and cause him to grasp the shaft or pulley to avoid a fall.

Belt poles should always be provided and kept in a definite place so a man will always know where to find one. It is quite as easy to shift a belt with a suitable pole as by hand and their use should be insisted upon. The pole should be sufficiently long so it can be held firmly against the hip and not in front of the body as serious accidents have happened due to a short pole becoming entangled.

When tight and loose pulleys are used and mechanical means provided for shifting the belt, the shifter should always be provided with some form of lock to hold it firmly when the belt is on the loose pulley so it cannot creep back on the tight pulley and start the machine

unexpectedly. When it is possible to do so loose pulleys should be mounted independently of the shaft itself as they are likely to sieze and thus start the machine. It is sometimes possible to mount the loose pulley on a stationary stud so arranged that the stud and shaft will line up on the same axis but be entirely independent of one another. Another way is to place a bushing on the shaft held from revolving by some external means, the loose pulley being mounted upon this bushing.

There should be a system of frequent inspection of belts in all shops. They should be examined for signs of rupture, especial attention being paid to the splices and laces. If a belt is not heavily overloaded it will usually show signs of rupture some time before the break occurs so by proper inspection the breaking of belts can be almost entirely avoided. Unshipped belts should not be allowed to rest upon the revolving shaft but a hook or hanger should be provided.

Pulleys sohuld be inspected occasionally for signs of wear and defects. Broken arms are the most common defects and may be detected by hammer testing. A pulley should not be placed nearer than one and one quarter times the width of the belt from a hanger, post or any stationary object without providing a guard so the belt cannot run off on that side.

PUNCH PRESSES.

Such records as are available seem to indicate that next to wood working machinery punch presses are responsible for the greatest percent of accidents of any class of machines. The principal source of danger is getting the hand or fingers crushed between the punch and die. The fly wheel and gears are sources of danger that can be guarded against by the methods previously described. The punch and die feature however is a much more difficult proposition.

Before attempting to apply a remedy let us consider the conditions under which punch presses are operated. There are two general methods of operations, continuous and intermittant.

In the continuous method the press runs continuously making about forty strokes a minute. This means that the operator must remove a finished blank, place another in position and get his hands out of the way within a time limit of about three fourths of a second. This is too close a limit and presses should not be operated continuously except where provision can be made for feeding whereby it will not be necessary for the operator to place his hands between the dies.

In the intermittant method a foot treadle is usually employed to operate the punch.

The blank is placed in position and the treadle pressed with the foot. The punch makes one complete stroke and stops. The blank is then removed a new one inserted and the operation repeated. The principal danger lies in the clutch failing to release thus causing the press to repeat and the great danger of the treadle being operated accidentally by an unconsious pressure of the foot or something falling on it.

The clutch should be so constructed as to be automatically and positively thrown out at the completion of the stroke. Many makers use such a clutch on their light, high speed machines but the heavier punches are usually equipped with a plain square jaw clutch and depend on a spring to pull it out when the treadle is released. These clutches usually release all right if the treadle is free but the operator may not always remove his foot from it a sufficient amount to allow it to release in which case the press would repeat. Therefore it is desireble to have all presses equipped with safety stop clutches. The best form of safety clutch with which the writer is acquainted is that used by the Queen City Punch and Shear Co. This clutch is positive in its action is strong and serviceable and has the additional feature that by simply pulling a lever it can be locked making its operation impossible. This feature is of great value when changing dies or adjusting

punches as it protects the operator without the necessity of throwing off the driving belt as is usually done.

The operation of a punch press is of such a monotenous nature that the operator performs the various movements in a purely mechanical manner. He goes through the same set of movements from twenty to forty times a minute day after day. It is impossible for a man working under these conditions to keep his mind on the work. He gets to thinking of other things and a slip or miscalculation results in the loss of a hand or fingers.

There have been many attempts made to provide guards for punch presses but most of them have been failures. They are either inefficient or they curtail the output to such an extent as to prohibit their use. The most common method is to arrange a bar or some fingers in such a way that they will sweep over or pass down in front of the dies in such a manner as to knock the hands out of the way before the ram descends. These are operated in two ways, by the ram itself and by the foot treadle. Those operated by the ram are of little use for they necessarily have to move at a high rate of speed and are capable of dealing a severe blow. A man becomes more afraid of the guard than the machine and he will not use it unless he is forced to do so, in

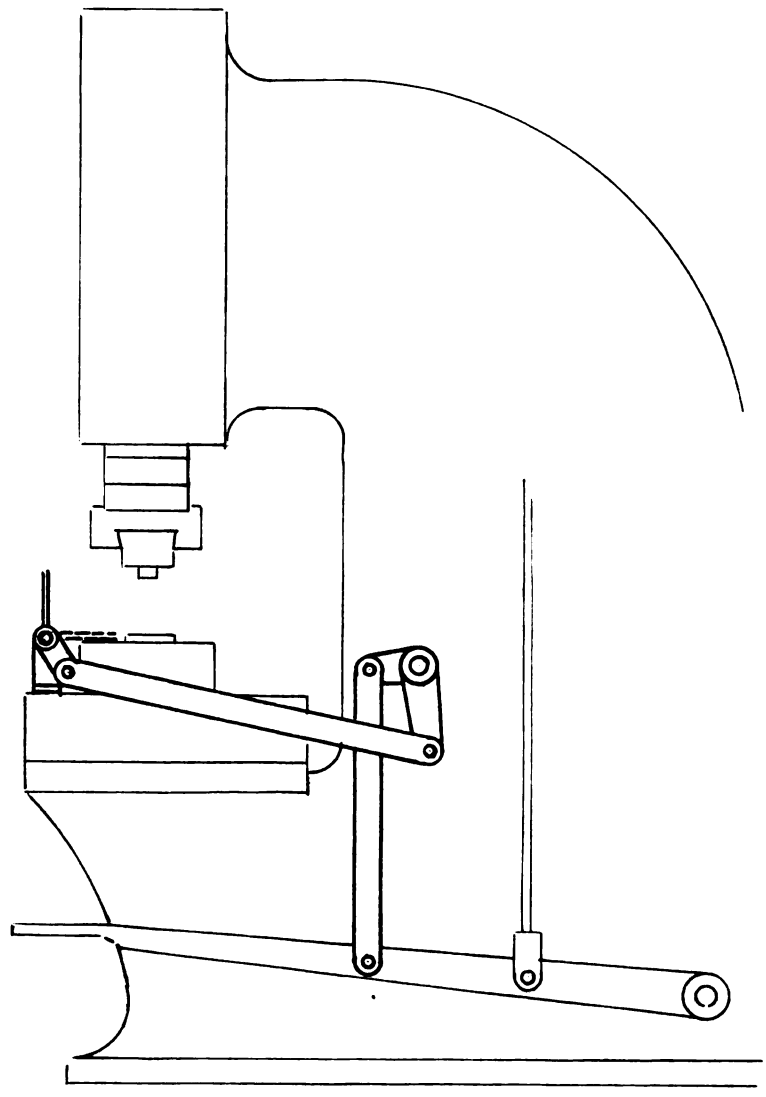


Fig. 37.

which case his output is curtailed and he becomes dissatisfied.

On certain classes of work a guard of this type may be used to advantage. It should be so arranged that the guard will complete its movement or nearly so before the press trips. Fig. 37. shows such a device. It is connected with the treadle through a bell crank and lays flat on the die when the press is not operating. The links should be so adjusted that it will rise nearly to the position shown before the press trips. The disadvantage of this type is that it usually has to be removed in changing dies so it can be applied to advantage only on presses that do not have to be set up frequently.

Fig. 38. shows the same idea in a slightly different form. This consists of an U shaped bar hinged on opposite sides of the press frame. The upturned portion extends across the front of the die. This has the advantage that it does not interfere with changing the dies but unless it is carefully proportioned there is danger of the hand being caught under the guard thus preventing its withdrawal. This danger can be guarded against by correct design. If the bar is properly shaped and adjusted it forms a pretty reliable safeguard.

The above illustrations show the operating principle of nearly all such guards. The details however have to be worked out for each

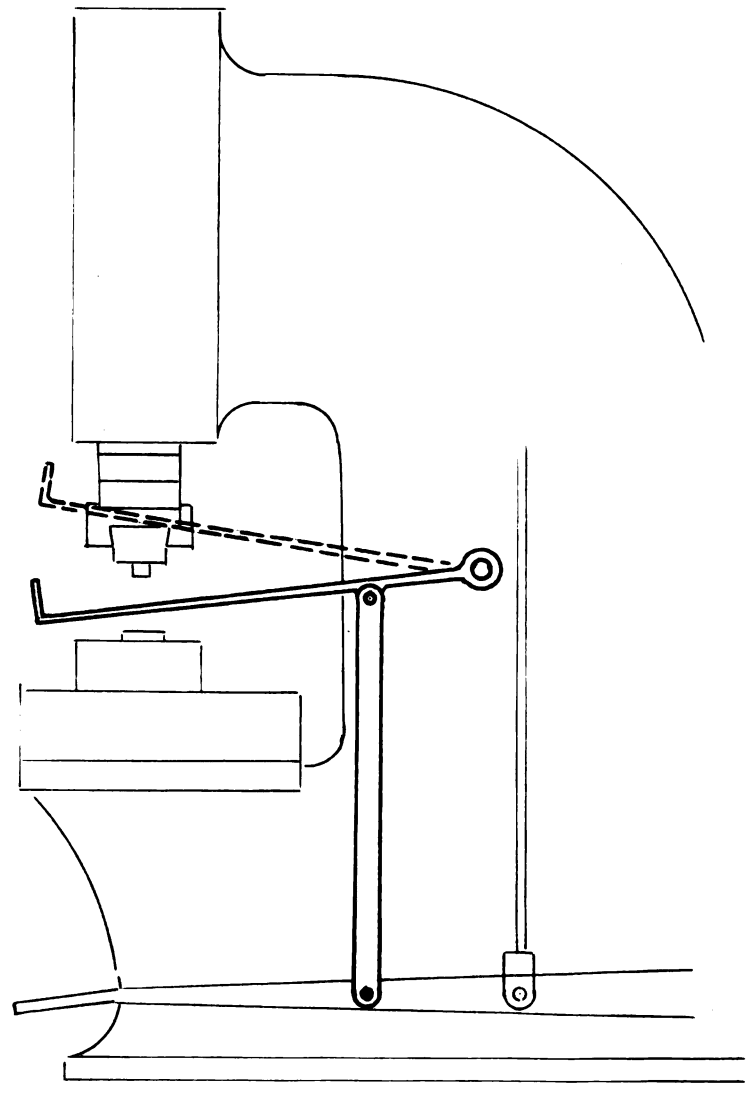


Fig. 38.

individual press. They must be correctly designed and carefully adjusted and their range of application is limited. Avoid all guards actuated by the ram. They may look all right in theory but they are inefficient and dangerous in operation.

We now come to the only really efficient safeguard having a general application with which the writer is familiary Fig. 39. It is obvious that for a man to get his fingers crushed he must have them between the dies when the ram descends. It is equally obvious that if we can make it impossible to trip the press until the hands are withdrawn we will accomplish the desired end. This end is attained by the device shown. F represents a pipe connected to the compressed air system, A is a stop cock, B & C are self closing air valves, D an air cylinder and E the trip rod. C should be a three way valve allowing the air in the cylinder to discharge when the valve is closed. The operation is simple. If either B or C is opened seperately the device will not operate, both must be opened at the same time. This requires the use of both hands thus forcing the operator to remove his hands from between the dies before he can trip the press. In applying this device care should be taken that the valve levers are of such a shape and are so placed that they cannot

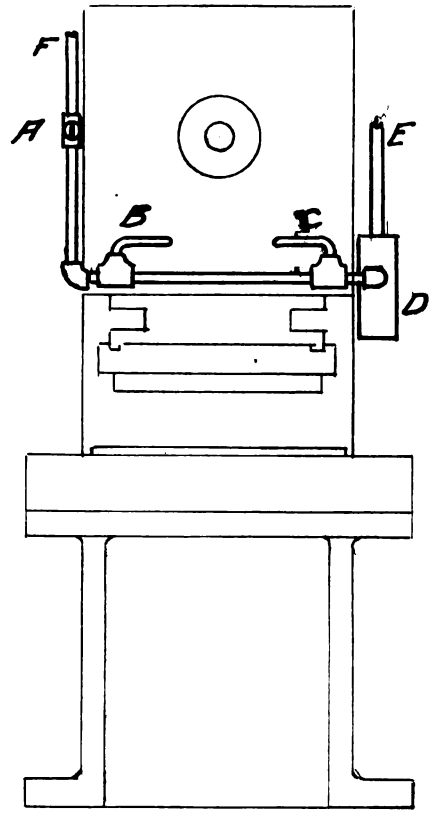


Fig. 39.

be tied or propped open. In cases where one hand is used to guide the stock and thus does not come between the dies one valve can be locked open, the key being in possession of the foreman.

In shops where compressed air is not available, an electric current may be employed by substituting push buttons in place of the air valves B & C and a solonoid for the air cylinder D. This scheme is very flexible, it can be applied to any press on any class of work, is efficient, cannot be tampered with and the valves or push buttons can be located in any convenient position.

Many attempts have been made to apply this idea to hand operated presses by arranging a hand operated lever in such a way as to lock the main lever in position. It is thus necessary to press the auxiliary lever and release the operating lever before the press can be tripped. These schemes have proven defective because the auxiliary lever can usually be rendered inoperative by hanging a weight on it, blocking it open or wedging the operating parts in some way.

It has been found that after the first few days the above methods do not curtail the output, on the contrary an increase has been noted in several instances.

STAIRWAYS, PLATFORMS AND RAILINGS.

All elevated platforms or runways should be first of all strongly made and rigidly supported so there will be no danger of thear collapsing. The best form of overhead run way is an all steel construction but a wood one can be made perfectly safe if it is carefully constructed and properly guarded. There are a great many overhead runways used in the steel mills for passing over roll tables etc. Fig. 40 shows the standard form of construction of a runway with the stairway leading to it. These runways are usually about thirty inches wide, are constructed of two seven inch channels with the flanges turned in, to the top of which is rivited a three eighths inch checkered plate. Channels of the same section are framed in at intervals crosswise to give stiffness and the whole is supported upon brackets attached to columns, trestles built up from the floor, hangers from trusses or other convenient means.

There are two types of railings used, the angle iron as shown in Fig. 40 and the pipe rail shown in Fig. 41. The angle iron railing is the best for all around purposes although the pipe railing is the more sightly. The sizes of angles and bars given on the sketch are the most desirable although 2 1/2 X 2 1/2 X 1/4 angles may be used if desired. The gusset

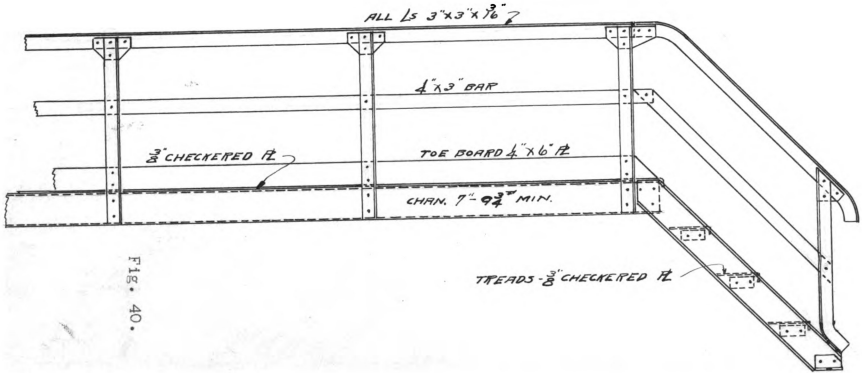

ALL Ls 3"x3"x 3/16"
4"x3" BAR
3/4" CHECKERED PL
TOE BOARD 4"x6" PL
CHAN. 7"-9 3/4" MIN.
TREADS - 3/8" CHECKERED PL

Fig. 40.

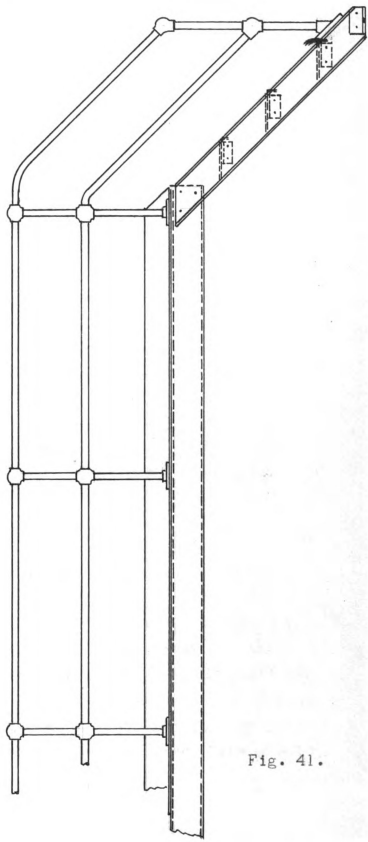


Fig. 41.

plates are 1/4". The height of the railing from floor to top should not be less than three feet six inches. In case the pipe railing is used it should be rigidly bolted down and made of not less than one and one quarter inch pipe. The toe board may be fastened in place with U bolts.

The stair channels should not be less than seven inch nine and three quarter pound, with the flanges turned out. The treads are three eighths inch checkered steel plate with the front edge turned down about two inches. They are rivited to connecting angles as shown the rivits being countersunk on the top side. The angle of inclination should be about forty five degrees.if possible, never gleater than fifty degrees. If a greater angle than this is required use a ladder. It is well to make the rise and tread the same as that used on other stairways about the plant.

Wood stairways should be carefully watched and not allowed to become too badly worn before renewing. It is a good plan to use checkered metal treads or at least protect the edges with strips of sheet brass or iron. If this is done however it should not be allowed to become ragged as this condition would be worse than a worn tread. When wood hand railing is used on a stairway or platform great care should

be taken to see that it is amply strong and well braced. Many serious accidents have occurred due to railings that looked strong but were not.

One of the most important safeguards in this connection is plenty of light. All stairways, runways, passageways, etc. should be well lighted and kept clean. Nothing should ever be left piled on a stairway or in a passage way.

WOOD WORKING MACHINERY.

Wood working machinery is generally recognized as one of the most dangerous classes of machinery to be found in the ordinary manufacturing plant. For this reason these machines have been given more attention than any other class and numerous patented safety devices are on the market with which they can be equipped. There are several firms who make a business of supplying these devices and full information concerning them can easily be secured. Therefore the writer will not describe them in detail but will confine himself to a brief general discussion of the subject, calling attention to the most efficient of these devices and illustrating a few special devices not generally known but having considerable merit.

Under the heading "Fly Wheels, Belts and Pulleys" various safeguards for belts and pulleys were described. Especial attention should be given to this subject in connection with wood working machinery as the speeds are very high and the danger from this source is especially great. It is also customary in the case of moulders, taper machines, planers, etc. to use one or more countershafts mounted on the floor. These are especially dangerous and every effort should be made to guard them thoroughly. If possible they should be com-

pletely enclosed. It is a good practice to run a pipe or angle iron railing down each side of the machine even if all gears are guarded, as they should be, to prevent a person falling against the machine.

The danger of slipping and falling onto a machine due to slippery floors is very great in a wood working shop. The action of shavings and saw dust on the floor is that of a polishing agent to both the floor and the soles of the workmens shoes. It is frequently necessary to put sand or water on the floor in front of a machine handling heavy work to enable the operator to keep his feet at all. Rubber matting securely tacked down is one of the best safeguards against this danger. It should not be allowed to become ragged or too badly worn and should be kept as free from saw-dust and shavings as possible. Concrete floors with a floated surface like sidewalks are excellent in this respect.

It is needless to say that an efficient exhaust system for the removal of dust, saw dust and shavings should be provided. The laws in most states require this but the factory inspectors as a rule are politians, not engineers, so their approval of an installation does not necessarily mean that it is of much value. The writer knows of one case in which a pipe was run from a machine through a hole in the roof, there

being no fan connection whatever. This arrangement satisfied the inspectors, not once but several times.

In too many cases the design of an exhaust system is left to the local tinner or is put in in a hit and miss manner without any definite plans. Frequently also a perfectly good system will be ruined by tapping into it for additional machines. It should be bourn in mind that the design of an exhaust system is an engineering problem of no mean proportions. One that must be solved for each individual installation. Furthermore we must not put too much reliance upon the statements made by the blower companies in their catalogs. They are in some cases notoriously incorrect. An efficient system should remove at least 80% of the shavings from even the most difficult machines and a much larger per cent from the majority.

The circular rip saw is probably responsible for as many accidents as any other machine. These accidents are due to two principal causes, contact with the saw because of the hand or work slipping or a man falling on a slippery floor and those due to stock kicking back from the saw. Thus a safety device to be efficient must guard against both of these dangers. There are but few devices on the market

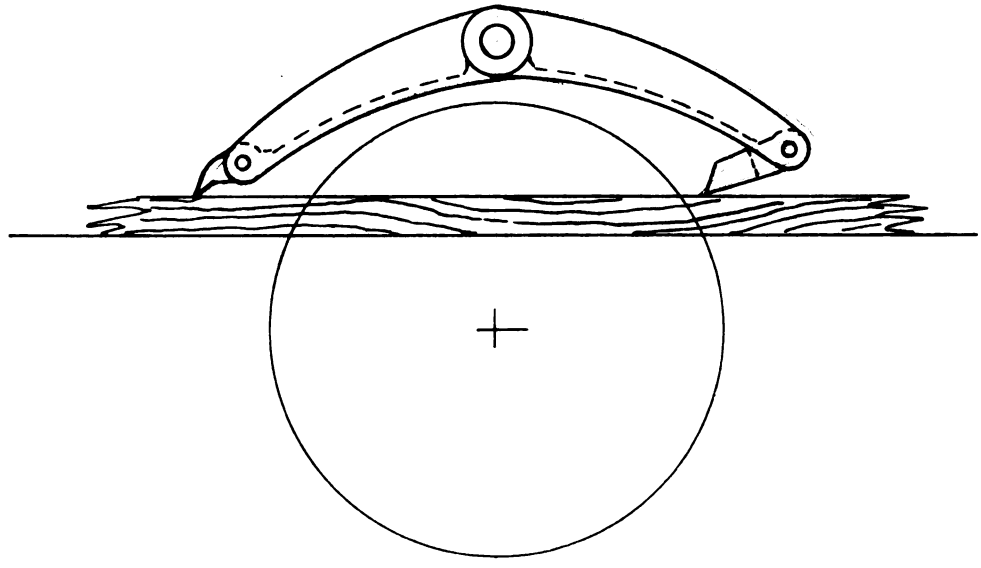


Fig. 42.

the majority being simply a cover for the exposed part of the saw so arranged that it may be adjusted to suit various thicknesses of stock.

The self feed rip saw if provided with a guard for the saw is a pretty safe machine. This cannot be overfed and the toothed feeding wheel prevents the stock from being thrown back.

For hand feed saws the device manufactured by the E. C. Atkins Co., Indianapolis, Ind. is probably the best on the market at the present time. This effectually prevents the stock being kicked back if sufficiently long stock in being sawed but it is of little value for very short lengths and it does not guard the saw sufficiently.

There is one device thit is not yet on the market but probably soon will be that, in the writers opiniony is by far the best of any device yet offered. This is shown in Fig. 42. As will be readily seen it effectually protects the saw and rigid tests prove that it is impossible for stock of any length to kick back from it. The upper castings are about four inches wide and adjustable to fit any size saw. The front fingers can drop to a verticle position but no farther. The fingers are about one eighth inch thick and separated by washers of of the same thickness.

Cut off saws are not nearly as dangerous as rip saws. If they are provided with a guard that will protect the upper part of the saw it is usually sufficient. The device sold by the Jones Safety Device Co., Buffalo, N. Y. known as the Jones Circular Saw Guard is perhaps the best adapted for this purpose. Swing cut off saws are pretty dangerous but are very easily guarded. A piece of iron about three inches wide bent over the upper half of the saw extending slightly below the center and fastened securely to the side of the swinging arm will protect the operator pretty thoroughly. One of the most dangerous features of these saws is that they are counterweighted. If the counterweight arm breaks or the weight falls off the saw will swing suddenly toward the operator. The above described guard will protect against this danger as effectually as any. A guard especially designed for this type of saw is made by the H. B. Smith Machine Co., Smithville, N. J.

Band saws can be very easily guarded so there will be but very little risk connected with their operation. Both the upper and lower wheels and the idle portion of the saw can be completely enclosed with wood or metal guards. There is a patented guard on the market that is adjustable to any size or make of saw. It is made of angle iron covered with wire netting and

is also fitted with a sliding piece covering the working portion of the saw so the only portion left exposed is that actually being used. Any band saw guard should be so designed as to prevent the saw flying in case it breaks or runs off the wheels as this is one of the most dangerous features of these machines.

Buzz planers or jointers probably rank next to circular saws in t he number of serious accidents tdey have caused. In operating these the piece being worked is pushed over the cutter head by hand. A split, cross grained or shakey piece, a knot or any one of a number of other causes may result in the piece being thrown from the machine and the operators hands come in contact with the knives. With the old style square head this usually meant the loss of one or more fingers as there is plenty of space between the flat side of the head and the edge of the table for the fingers to pass in and the tendency is for the knives to draw the fingers into this opening. Happily the square head is being rapidly superceded by the round head which does not leave this opening and has only the cutting edge of the knife exposed. The action is similar to that of a hand plane. It will cut the ends of the fingers badly but cannot cut them off. The two best types of round heads are those made by the Oliver Machinery

Co., Grand Rapids, Mich. and the Berlin Machine Co., Beloit, Wis.

There are many forms of guards, most of them patented, for preventing the hands from coming in contact with the knives. One very good one consists of wood strips attached to two pieces of leather pivoted to the side of the table and held in place by a spiral spring underneath. As a board is passed over the knives the guard is pushed to one side and only that portion of the head actually being used is uncovered the guard immediately springing back to position when the board passes through. This device is patented and sold by a Chicago firm. Another good device is that sold by the Jones Safety Device Co., Buffalo, N. Y. This consists of flat sections of cast iron sliding together and held in position by a rod at the side of the table. It is adjustable vertically by a hand wheel. The board passes under the guard and the hands over it. In jointing the edge of a piece the sections may be telescoped by pulling a jointed rod at the end thus uncovering a sufficient portion of the knives between the guard and the fence to accomodate the stock.

Another exceedingly dangerous machine is the wood shaper. Like the buzz planer this can be easily guarded so it will be reasonably safe and it should never be operated without a guard. There are many guards on the market one of the best being that of the Jones Safety Device Co., Buffalo, N. Y.

MISCELLANEOUS SAFETY DEVICES.

COUNTERWEIGHTS.

Large numbers of counterweights are used around factories and they are not often guarded. In most cases they should be. Such machines as boring mills and planers use very heavy counterweights and they are often hung in such a position that they are exceedingly dangerous if the rope or chain supporting them should break. These ropes or chains usually do break sooner or later and it is purely a matter of luck if no one happens to be under when they fall. These counterweights should always should always be guarded in such a way that a person cannot at any time get in under them. The best guard that can be used when there is clear floor space underneath is a piece of gas pipe of sufficient size to enclose the counterweight fitted with a standard flange which is bolted to the floor. This is particularly effective in cases where it is near a trucking way or any place where it is likely to be struck by moving objects. A tube of sheet steel with a flange at the bottom bolted to the floor in the same manner is good enough for many places and is cheaper than the pipe.

Where a counterweight is located near a wall it can be easily boxed in. This is the case with the weights used to counterbalance fire doors. These doors are usually mounted on an inclined track and the counterweight

suspended by a light cord so in case of a fire the cord will burn off and the door close of itssown weight. The fact that light cords are used makes it necessary that the weights should be boxed in.

A very dangerous form of counterweight is that used on punch presses. These are usually very heavy and located in a dangerous position and are very hard to guard effectively. The brackets, pins, ect. should be carefully inspected at frequent intervals to guard against wear and a safety pin should always be used in the end of the arm to prevent the weights falling off if they should become loose. These counterweights can be eliminated entirely by using an air cylinder. These cylinders use no air but simply work against the pressure. There should be a small reservoir connected in the line between the main line and the cylinder, fed through a check valve, so in case the air suddenly goes off the main line the device still remains operative.

GRINDING WHEELS.

There are four principal dangers to guard against in the use of emery wheels, Breakage, contact with the wheel, flying particles of emery and dust. The first two can be taken care of by a properly designed hood. The hood will also

partially protect against flying particles but the use of goggles is the only entirely safe method. The hood should be sufficiently strong to hold the wheel in case it breaks. It should fit the wheel as closely as possible and leave only as much of the surface exposed as is necessary for use. Safety collars should be used wherever possible and the speed should never be in excess of thit recommended by the makers. Care should be taken in mounting the wheel to see that it fits the arbor closely and runs true.

While the damage caused by dust is not immediately apparent it is nevertheless very serious. The percentage of consumption and other lung troubles amoung workers in grind shops is very high. In ordinary shops where only a few wheels are used for tool grinding and similar purposes the dust is not noticible but in shops where grinding and polishing is done exclusively it becomes very disagreeable as well as dangerous to the health.

At the Plow Factory of Deere & Company there are 130 twenty inch wheels used in one room. The air is so foul in the room that a person going in from the fresh air outside has difficulty in breathing at first, notwithstanding the fact that a dust collecting and separating system is in use. The company has greatdifficulty in keeping men as some men can only stand it for a few months and the most of them not longer than

three or four years. To keep men at all very high wages must be paid, in fact the average hourly wage is higher than any other department in the works except the forge shop and it is in no way skilled labor.

There are many difficulties that must be overcome before this dust can be eliminated. It cannot be discharged out of doors owing to the close proximity of paint and other shops, furthermore a fan capacity sufficient to handle the dust at the wheels would change the air in the room every three and one half minutes making it impossible to heat in the winter. Therefore the dust must be removed from the air sufficiently so that it may be discharged back into the room. There is no commercial system in existance that will do this but we have perfected one here that has been tried out in some of the smaller shops during the past winter with very satisfactory results. The writer has designed a complete system for the large shop that will be installed during the coming summer. Eleven 70 inch fans direct connected to 20 horse power motors will be used to handle the air and each fan will have an individual separator. I am not at liberty to discuss the principle of operation of this separator at the present time as it is regarded as a trade secret but it will remove over 95% of the dust from the air and the cost of installation and operation is not high.

OXACETYLENE INSTALLATIONS.

The rapid increase in the use of acetylene gas in the shop for welding and cutting metals makes it necessary that the dangers connected with its use should be clearly understood. There is a popular belief that acetylene gas itself is explosive. This is not true as acetylene in the absence of air or oxygen is not explosive and will not ignite. Calcium carbide, the substance from which it is evolved, is an inert substance that may be pounded with a hammer without result. Calcium carbide is a compound of lime and carbon which when brought in contact with water gives off acetylene gas (C_2H_2) leaving a residue of slacked lime. As will be seen from the chemical symbol acetylene is in the same class of hydrocarbons as city gas or gasolene vapor and must first be mixed with air or oxygen and a naked flame applied before ignition can take place. Therefore to prevent explosions we must prevent a mixture forming in any part of the apparatus.

There are two types of generators in common use. One feeds the carbide in small quantities automatically into a tank of water. The other drops the water automatically onto a body of carbide.

With the latter method the generating temperatures are apt to be very high, from 400 to 700 degrees Centegrade. Thus the temperature in the generator is apt to be above the ignition point of a mixture of acetylene and oxygen and

if oxygen should find its way into the container an explosion would occur. This is something that could happen as will be shown later. Furthermore when recharging a generator some air is bound to be admitted. This air is usually carried off with the first gas that is evolved and thus gotten rid of before a high temperature is reached. There is however a chance that this would not happen and as acetylene explosions are very violent and dangerous it does not pay to take chances.

The second type accomplishes cool generation as a relatively large volume of water is used, one gallon for each pound of carbide contained. With this type the National Board of Fire Underwriters allow one cubic foot of gas per hour for each pound of carbide contained to be drawn from the generator. With the water feed type only one half this amound is allowed.

The greatest danger connected with the operation of an acetylene plant is in refilling the machine with carbide and water. It is during this operation that probably nine tenths of the accidents occur. All machines are provided with a vent so the gas in the generator may be drawn off. Fhen the pressure is brought down to that of the atmosphere the machine still remains filled with gas at atmospheric pressure. As this gas is nearly as heavy as air it moves very

slowly and air entering the generator soon forms an explosive mixture. If an open flame is brought near an explosion occurs. Therefore it is necessary that the generator be so placed that it can be recharged without the aid of artificial light.

In operation the acetylene is under a low pressure, not over 11 pounds, as a pressure greater than this will cause the gas to flow at a speed greater than the rate of combustion and the flame will blow out. The oxygen however is under a pressure of from 12 to 200 pounds depending upon the class of work being done. Now if the end of the torch should become stopped up for any reason the oxygen would pass into the acetylene generator forming an explosive mixture. To prevent this a back pressure valve should be used. Suppose a back pressure has occurred and been relieved by the valve. The valve and line is still filled with a mixture under a pressure equal to that of the acetylene generator. If in lighting the torch the torch cock is only partly opened the speed of the gas may be less than the rate of ignition in which case there will be an explosion of the gas in the line. This is known as a flash back and may be prevented by inserting several layers of fine mesh wire cloth in the acetylene pipe. This will stop the flame in the same manner as the Davy lamp.

A fluted plug in the acetylene pipe will accomplish the same purpose and is not as easily obstructed.

There are two sources of oxygen supply. One to purchase it in cylinders and the other to generate it. The storage cylinders are of seamless steel tested to about 3,500#.by hydraulic pressure and annealed. The pressure of the oxygen when the cylinder is full is about 1,700#. As the corrosive action of pure oxygen under these pressures is very great these cylinders should be re-annealed and tested at least every two years.

At the present time the most common method of generating oxygen is by heating a mixture of chlorate of potash and manganese dioxide in a retort. By this method a considerable amount of chlorine is present and this must all be removed as chlorine and acetylene will immediately explode when brought into contact, the explosion being accompanied by a red flame and a deposit of carbon. To remove all the chlorine requires that the purifying solution be very carefully watched and kept up to standard. The Underwriters require that acetylene and oxygen generators be installed in separate rooms and this should always be adhered to. The reason for this is apparent from the above as a leak in both generators at the same time with chlorine present would result in a very disasterous explosion if they were in the same room.

In filling, cleaning and again starting an acetylene generator there are several separate operations that must be preformed in their proper order otherwise there is apt to be trouble. It is therefore essential that the operator thoroughly understands the operation of his machine, that he understands the nature of the gas and the various sources of danger. It is also necessary to have someone about the plant other than the regular operator who can operate the machine in case the regular man is sick or absent. A large number of the accidents that have occured have been due to someone trying to replentish the machine with carbide and water who did not understand it.

A great deal has been done by manufacturers of acetylene apparatus to make it "fool proof". The valves are so constructed that they must be opened and closed in their proper order. The flush out gate is so arranged that it must be opened before the cover can be removed. This makes it impossible for the operator to neglect flushing out the machine when filling. Both flushout gate and cover must be closed and secured before the machine can be put in operation. The water level is automatically maintained and the overflow pipe connected with a syphon to prevent its filling up with residue.

Acetylene is like gasolene in that it is perfectly safe if properly handled but exceedingly dangerous otherwise.

SOME PHOTOGRAPHS OF PRACTICAL SAFEGUARDS.

The following photographs taken in the plow factory of Deere & Co. at Moline where the famous "John Deere" plows are made illustrate some good examples of practical and efficient guards.

Number 1 shows a special automatic machine for making eye bolts, singletree hooks, etc. The triangular shaped cast iron guards shown on the corners cover the miter gear drive and are incorporated in the design of the machine. At the right we have the belt and pulley guarded. This guard however should have been higher. At the left is shown the cam shaft guarded and a guard placed in front of the hand wheel. T his hand wheel is used to turn the machine over slowly when setting it up. The guard is placed far enough away from the wheel to allow it to be used for this purpose yet the spokes are thoroughly guarded. At the right in the back ground is seen a press with the pulley spokes guarded by a steel disc.

In number 2 we have shown a special machine for rounding the end of bolts before threading. Here the driving belt, pulley and head are guarded and a sheet metal guard placed over the die. In the back ground is a belt and pulley guard for another machine.

Number 3 shows a special automatic bolt heading machine. This machine is entirely enclosed

on both sides and back.

A battery of drill presses is shown in number 4. These are backed up to a passage way and are fenced off as shown. The spindle drive is also guarded by a plate guard which is shown in position on the two outside machines and removed from the center one.

A U bolt bending machine is shown in number 5. The pulleys, belts, driving head and operating head are all guarded.

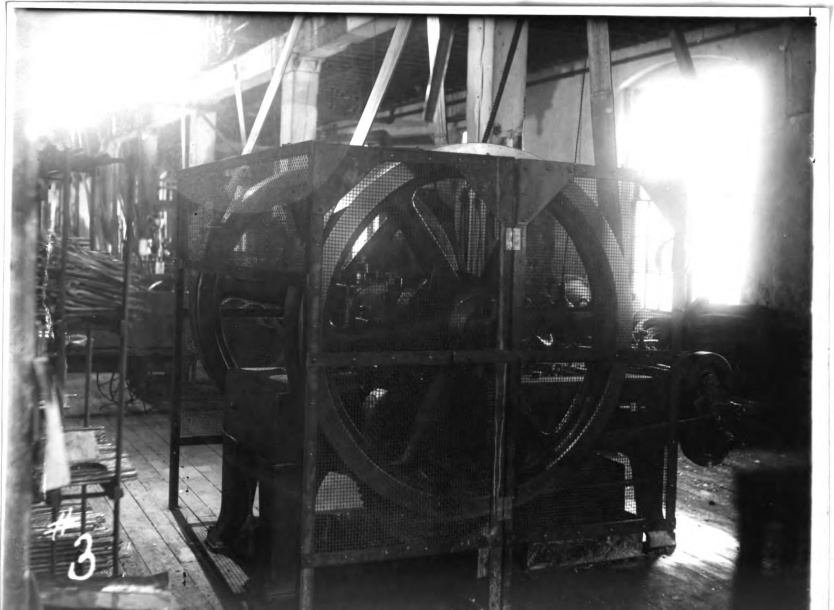
Number 6 shows the method used to guard a bulldozer. This guard is only partially completed. Tde frame in entirely covered with wire screen and doors such as that shown at the back are placed at such points as must be accessible.

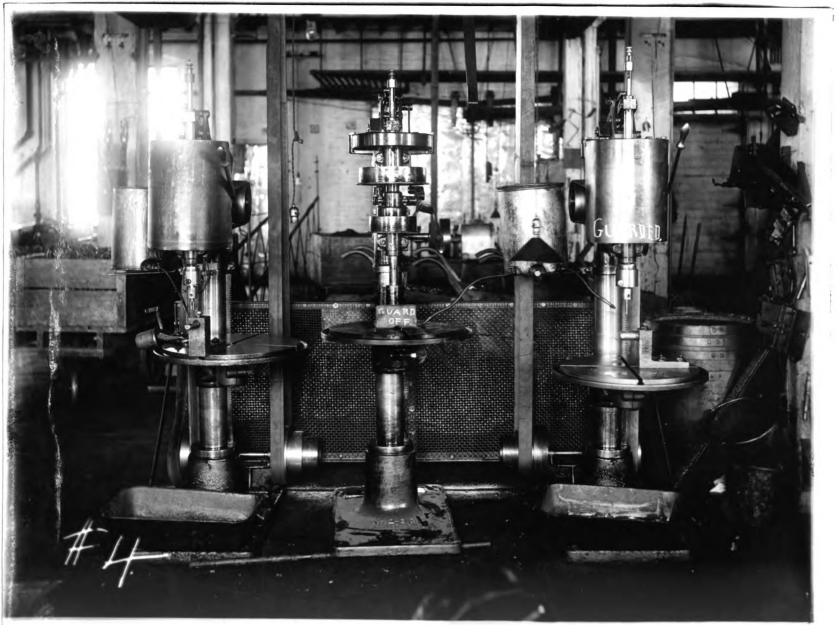
A punch press with the gears guarded is shown in number 7 and one still unguarded at the right.

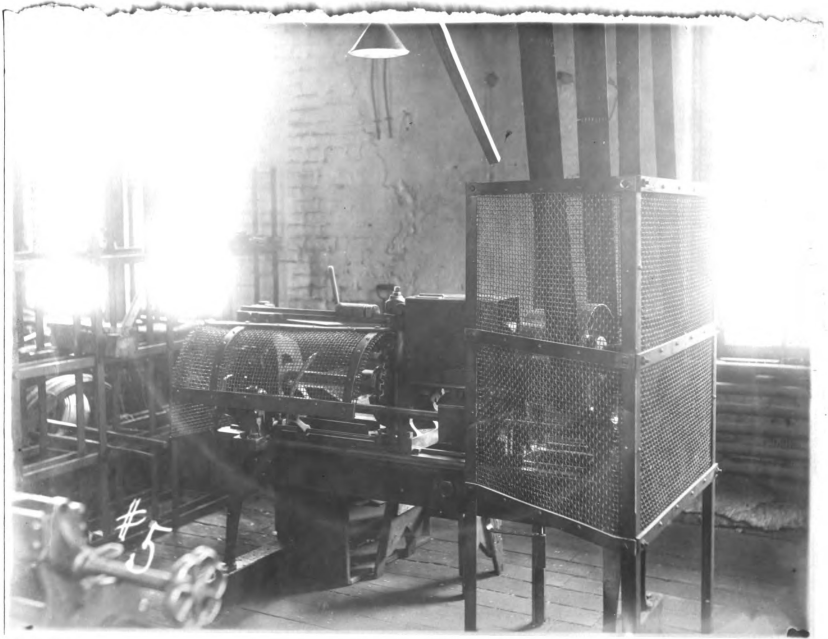
Number 8 shows the belts and pulleys on a drill press guarded. In the writers opinion this guard should have been at least two feet higher.


#1

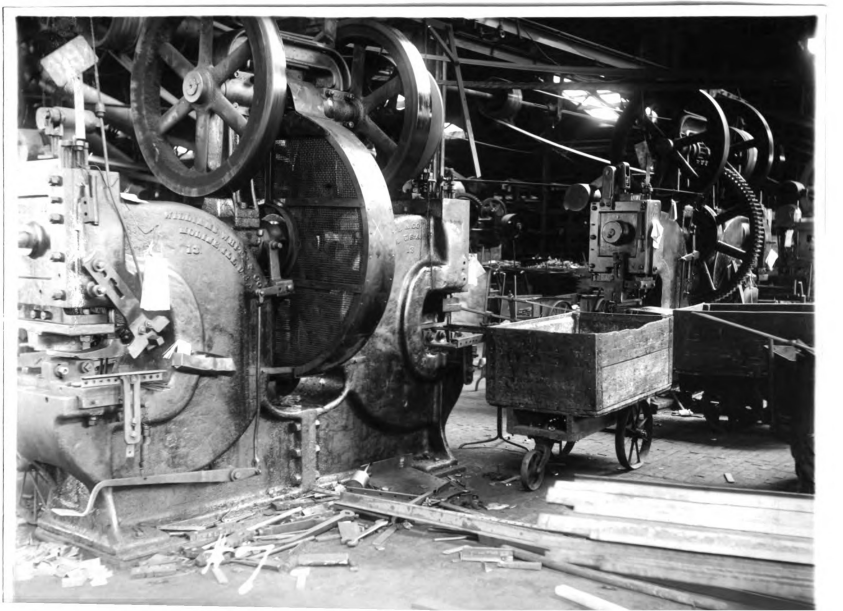

#2


#3


GUARD
OFF
#4.


#5


#6




#8

ROOM USE ONLY