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ACCIDENT PREVENTION IN CEMENT PLANTS.

BY

EDWARD REES ABBOTT

A

THESIS

submitted to the faculty of the
SCHOOL OF MINES AND METALLURGY
OF THE UNIVERSITY OF MISSOURI

IN partial fulfillment of the work required for the
Degree of

BACHELOR OF SCIENCE IN MINE ENGINEERING

Rolla, Mo.

1924.

Approved by

C.T. Forbes

Professor of Mining

After a comprehensive study of industrial accidents in 1908, the Department of Commerce and Labor estimated that there are from 30,000 to 35,000 fatal and not less than 2,000,000 non fatal accidents in the United States every year.

In Massachusetts during the year ending June 30, 1913 there were reported to the Industrial Accident Prevention Board 90,168 accidents 474 of which were fatal. These 90,000 accidents caused 1,156,787 days lost time; this is equivalent to 3855 persons being constantly disabled. The cost to employees through loss in wages alone, was \$2,965,225 or about \$10,000 for each working day of the year. The cost to employers in compensation premiums alone was approximately \$4,000,000. Add to these items incidental accident expenses due to loss of product, disorganization of working forces, cost of maintaining hospitals and other charitable institutions for injured workmen, the care of dependent families whose wage earners are incapacitated by accidents and the total for the United States may well run into the hundreds of millions of dollars per annum. (From Industrial Accident Prevention by D. S. Beyer.)

No provision had been made in the United States for compensating injured workmen until 1910, when New York State passed a Workmen's Compensation Law. Germany in 1884 and Great Britain in 1897 had drafted compensation Acts.

However today, all States in the Union have enacted Compensation Laws. These laws differ materially in different States. In most States insurance in authorized liability companies is permitted. In some States employers are permitted to carry their own insurance, while in others they carry a State fund managed by the Compensation Board. The Province of Ontario, Canada has a very good Workmen's Compensation Act, which is very fair to both employer and employee. The entire fund is handled by the Workmen's Compensation Board. Each employer is required to pay into this fund a certain percentage of his payroll each year. All payments to and settlements with the injured employee, are made direct by the board. The board's decision is final, there being no resort to the law courts. The board maintains its own medical department and investigates every accident thoroughly. Good safety work and a reduction in the accidents on the part of the employer, is awarded by a reduction of the payment into the fund.

However compensation acts may be carried on, they have a decided influence in promoting accident prevention in the different industries. Other influences have also had their share in the promotion; the humanitarian standpoint and the good results obtained by the pioneers in Accident Prevention Work.

The United States Steel Corporation was one of the first companies to start Accident prevention work, having started their campaign as early as 1906. The good results

3.

which they obtained encouraged other companies to follow suit until today, due in a great measure to the activities of the National Safety Council, there are very few industries where accident prevention work is not carried on.

In the early days of the cement industry it was considered one of the necessary evils, that a certain number of men should be killed or injured each year. But the attitude of the cement manufacturer today is well presented by the remarks of E.M. Young, First Vice President of the Lehigh Portland Cement Company.--" In my opinion as an executive, safety work has become as necessary and essential to the successful operation of a cement mill as a boiler house or a laboratory. "

The cement industry as a whole took up accident prevention work along with the pioneers. With the organization of the Portland Cement Association, a Bureau of Accident Prevention was formed. This Accident Prevention Bureau, by sending out literature, holding competitions, collecting and tabulating results of accidents collected from every cement manufacturer and affiliating with National Safety Council as the Cement Section, has made rapid strides each year, until today it is doubtful if any other branch of manufacturers can show more improvement in accident records than the cement industry. In spite of their marked improvements each year, there were 47 fatal accidents in the cement industry in 1922, which shows that there is still room for improvement.

Table I., shows the record of 44 cement plants(half the cement industry in the United States and Canada) for the years 1919, to 1922 and improvements each year can be noted.

Before dealing with the methods of preventing accidents in a cement plant, it will be well to take up the hazards that are ever present.

Quarrying.

Quarrying, on account of the large shots that are put off, is generally considered one of the worst hazards of a cement plant, but on account of it's known dangers, the men employed here are generally more careful than when working in places of less evident danger, so that the accident frequency in quarries, does not exceed that of other parts of the plant. Whole sides of a quarry are often blasted down in a single shot(see illustration 1) and unless systematic warning signals are employed, wires tested etc., there is always danger of some one being injured.



Illustration 1.

Table- 1.

Time loss reduced 43% by 44 plants.

Plant Number.	NUMBER OF ACCIDENTS				NUMBER OF DAYS LOST.				NUMBER OF DAYS-LOST PER 100,000 MAN HOURS.			
	1919	1920	1921	1922	1919	1920	1921	1922	1919	1920	1921	1922
1	22	24	5	4	372	413	20	35	38.8	38.7	1.8	3.3
2	86	99	48	13	659	931	709	147	53.9	54.0	55.0	11.3
3	50	52	45	6	852	1038	442	99	121.5	97.0	49.2	13.2
4	9	16	12	13	115	155	163	108	27.3	31.1	29.5	19.4
5	48	64	23	18	1031	1001	415	322	49.9	52.1	28.6	19.5
6	*	*	7	5	*	*	100	135	*	*	13.0	20.5
7	37	40	38	17	535	639	517	174	66.0	73.1	57.5	21.2
8	15	*	10	8	197	*	150	100	49.9	*	34.9	22.2
9	11	14	11	8	379	455	131	105	66.8	92.3	27.5	24.9
10	24	19	*	9	455	376	*	69	128.2	85.1	*	25.1
11	63	83	58	42	815	1970	747	569	47.2	132.8	70.0	26.2
12	38	38	29	19	756	696	735	481	57.0	35.5	42.0	28.4
13	*	*	37	12	*	*	396	242	*	*	36.8	29.3
14	16	14	16	8	689	270	148	139	141.0	56.1	35.0	31.1
15	46	43	32	22	443	478	385	221	55.6	63.4	61.1	31.2
16	37	31	37	27	749	540	521	389	70.1	51.7	52.5	35.6
17	31	46	26	22	839	737	476	436	67.0	44.3	39.1	36.9
18	22	21	16	10	357	119	304	111	170.6	37.7	117.3	37.1
19	20	19	20	29	259	614	907	357	43.2	61.6	39.1	37.3
20	32	41	46	19	363	396	454	260	80.2	67.2	88.7	37.6
21	13	46	16	15	189	486	212	174	71.6	102.9	46.6	37.9
22	*	*	*	5	*	*	*	109	*	*	*	39.2
23	47	59	46	58	440	694	587	408	57.2	59.3	69.3	39.3
24	*	16	18	16	*	350	270	198	*	66.4	77.5	40.9
25	45	47	45	32	662	673	520	468	71.3	55.7	44.8	42.1
26	*	40	47	33	*	*	701	459	*	106.3	74.0	42.3
27	46	50	29	16	1006	1189	860	416	55.2	46.1	50.4	42.6
28	11	10	6	6	166	1048	118	98	90.5	54.2	53.8	43.9
29	*	*	29	20	*	149	263	292	*	*	40.6	44.2
30	40	43	51	34	814	482	766	521	80.5	44.2	59.8	44.5
31	*	*	20	12	*	*	272	147	*	*	80.2	44.8
32	32	40	29	23	654	370	536	323	102.3	50.4	77.5	46.9
33	44	49	42	81	381	532	420	527	39.8	48.5	42.8	47.8
34	90	90	48	36	600	1564	876	832	43.5	105.4	51.7	51.0
35	23	48	67	13	735	908	885	334	114.1	103.8	114.2	51.3
36	18	*	19	21	690	*	903	524	64.8	*	83.3	51.4
37	11	12	*	17	250	295	*	209	73.6	78.7	*	52.1
38	13	47	69	48	462	806	934	641	56.2	59.5	83.0	57.4
39	*	*	19	19	*	*	403	532	*	*	42.3	58.7
40	*	*	*	28	*	*	*	228	*	*	*	59.8
41	16	17	19	13	228	513	874	217	94.6	178.7	304.5	63.2
42	70	72	43	44	1101	774	1095	549	155.6	93.6	129.1	66.5
43	27	12	21	14	560	316	202	198	143.4	80.2	46.7	68.7
44	30	20	24	35	227	517	108	384	41.7	97.0	17.4	68.9
Total	1186	1382	1223	950	19,030	22,494	18,925	13,287	68.3	68.2	56.0	38.4
												Reduction 43%

* Did not report.

From the Nov.-Dec., 1923 number of the Accident Prevention Bulletin, issued by the Portland Cement Association.

Danger is always present in the handling, storing and thawing of dynamite, careless handling of detonators and the practice of crimping caps with the teeth, not to forget the habit of tamping the dynamite into the holes with metal tampers. Many fatal accidents have been caused by premature explosions due to tamping with a metal bar or rod. While rock flies to a considerable extent from the large shots, men all over the plant have been amply warned and are on their lookout, so that the greatest danger from flying rock is due to the blister shots(breaking up large pieces of rock to a suitable size for the crusher) . These shots cause large pieces of rock to fly all over the plant. At one plant for instance, a piece of rock 20" in diameter came a distance of 600' from the quarry, broke thru the machine shop roof and narrowly missed falling on a machinist at work on his lathe. Then there is the danger from the steam shovels employed in the quarry. Often the operator will swing or drop the dipper suddenly and unless the pitman is constantly on guard, he will stand in danger of being struck by the bucket. As the bank of the quarry against which the shovel is working is shot(loose) rock there is constant danger of starting a slide or loosening a piece of rock at the top of the bank. As most quarries transport their rock to the crushers by means of small locomotives and side or bottom dump cars(holding from 8-10 tons), there is danger of men being caught while coupling or of being run over. The majority of cement quarries now employ well drills for drilling their holes. While very few accidents have happened due to the mechanism of the

well drill itself, there have been some very severe accidents caused by the transportation of same. They are generally moved by hitching a team of horses to them, and if precaution is not taken there is liability of them getting away over the bank or down the hill. They are most generally moved on very uneven ground.

Crushers

One of the greatest hazards in connection with open mouthed crushers is the danger of men, working around them, falling in. This danger can be eliminated by having the men wear a Safety Belt and Rope.

Roll Crushers cause the rock to fly off the roll. Danger from this source can be eliminated by erecting a guard similar to the one shown in Illustration 2.

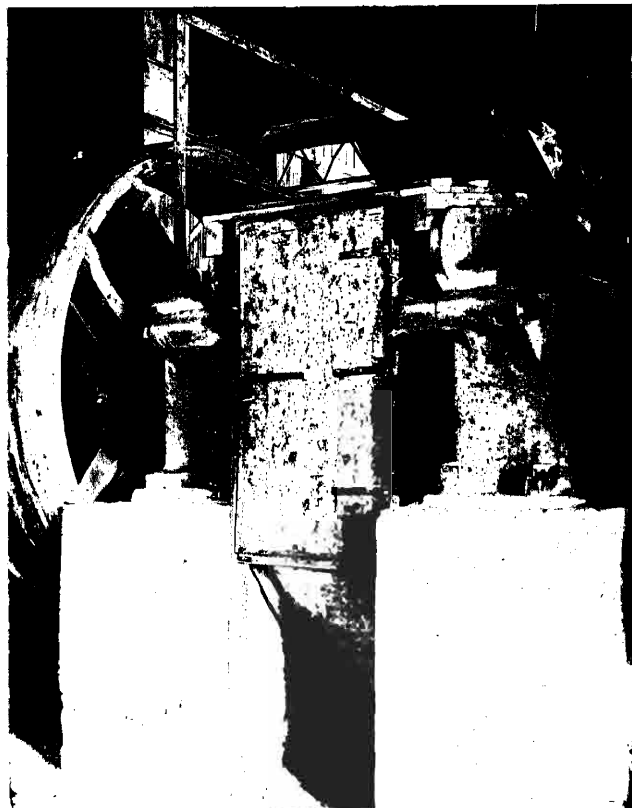


Illustration 2.

Handling Material.

The handling of material is generally responsible for a large percentage of accidents. This is accounted for by the fact that a large part of all industrial operations consists of handling material. The great majority of material in a cement plant is handled mechanically.

I have already taken up the handling of material in the quarry.

In other parts of the plant material is handled to a very large extent by elevators and conveyors.

Elevators, generally being entirely encased, present very little danger, outside of the driving mechanisms. In the event of the elevators not being enclosed in metal casings, there is danger of material falling from the buckets, unless protection is offered in the way of screens.(See Illustrations 3 & 4.).

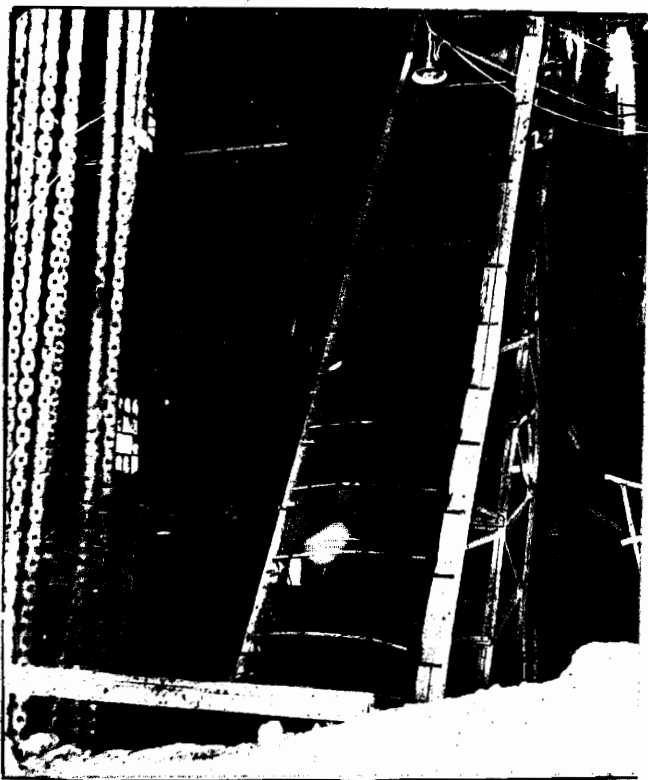


Illustration 3



Illustration 4.

Conveyors.

Various types of conveyors in common use are the bucket, pan, scraper, belt and screw conveyor.

The Screw Conveyor (illustration 5.) has been responsible for a large loss of life and the loss of many limbs.

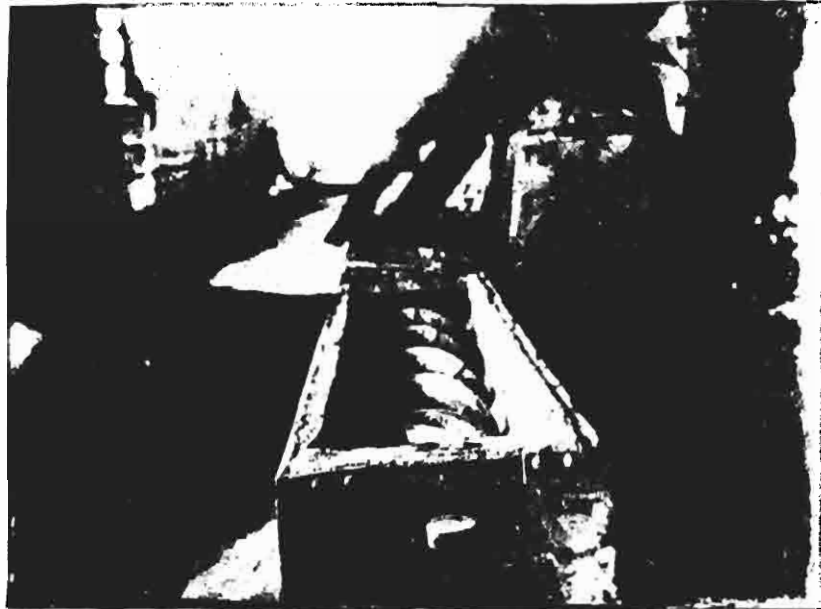


Illustration 5.

Being nothing more nor less than a revolving steel helix, it works on the same principle as a meat grinder and if any part of a man's clothing or body is caught by the screw, he will be pulled in and mangled unless the conveyor is stopped. These conveyors are often built with their tops flush with the floor level (Ill. 6.) and if covers are left off men often walk into them. Sometimes there is a flood of material and if covers are not securely fastened down they will be pushed off by the flood. In the kiln room and dryers, the dust from the stacks collects in the dust housings. These housings are cleaned by pulling the material into screw conveyors by means of hoes. Unless the conveyor is provided with a grating thru which the

material can pass(Ill. 7), there is great danger to the men performing this operation.

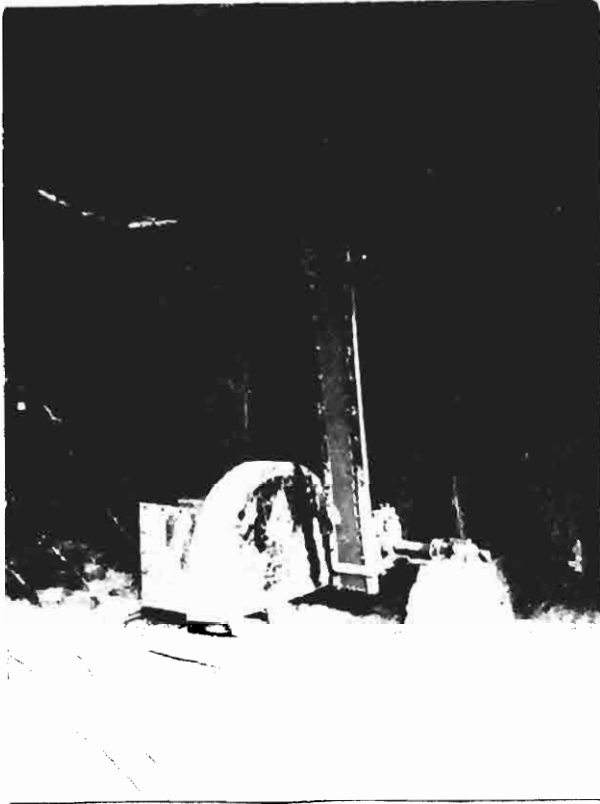


Illustration 6.



Illustration 7.

Bucket and Pan Conveyors.

The principle hazards connected with these conveyors are from men stepping on the buckets while the conveyor is in motion, and getting caught and crushed or mangled. Illustration 8, shows a bucket conveyor on which a workman was killed. He stepped on one of the buckets and was caught and carried along until he was crushed between the conveyor and a metal chute. This in spite of the fact that steps over the conveyor had been provided at frequent intervals.

Scraper Conveyors.

Scraper Conveyors are not in themselves dangerous, provided there are plenty of steps furnished for crossing over.

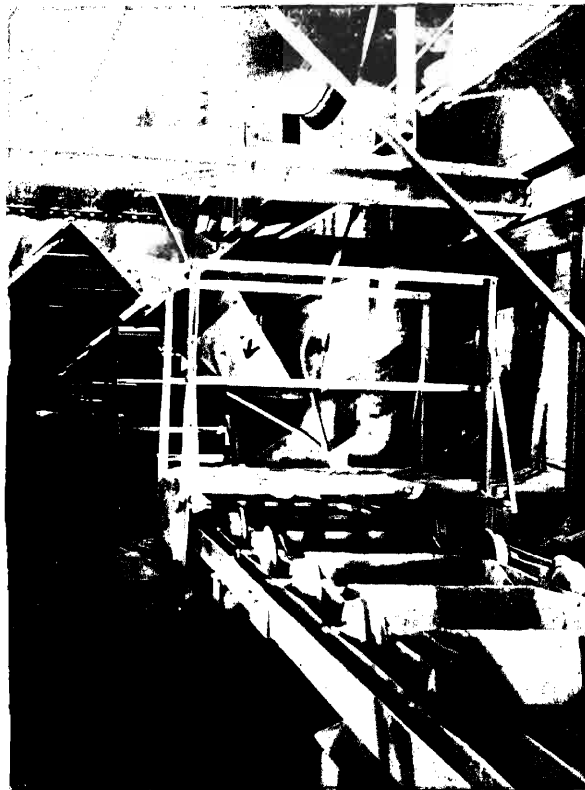


Illustration 8.

Belt Conveyors.

The chief hazard in connection with belt conveyors is the temptation for men to ride on them, particularly when the conveyor is inclined, as it will save them a long walk up the stairs. This hazard can be overcome by providing metal guards at frequent intervals, similar to the one shown in Illustration 9.

Locomotive Cranes.

Locomotive cranes are used to a large extent around cement plants for unloading and loading coal, handling heavy castings, shunting cars etc.. Outside of the regular railroad yard hazards, there are the additional dangers of men getting struck by the bucket or of being caught on the revolving table.



Illustration 9.

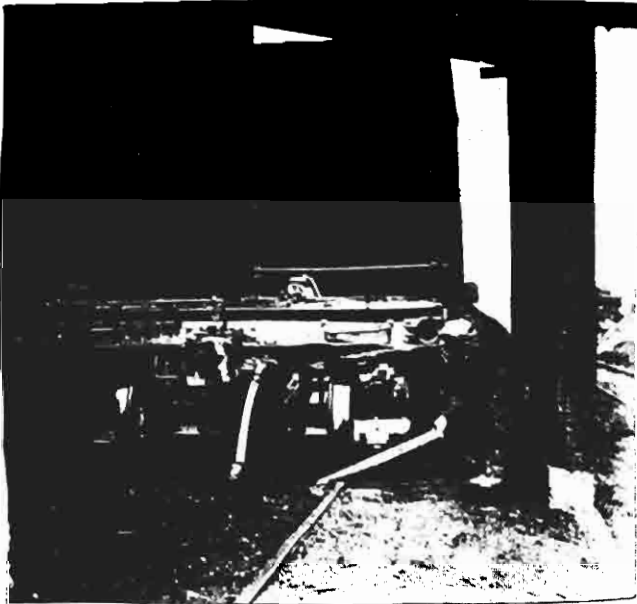
Railroads.

It is quite common in cement plants, to have railroad tracks running into many parts of the plant, not only around the yards but into storages and shops as well. In addition to the trunk lines coming into the plant, many companies own and operate their own rolling stock. Here the hazards of all railroads exist; crossing tracks, coupling cars, jumping on running boards, bumping into standing cars, flying shunts, etc.. At one plant a workman was killed in a peculiar way. It was the custom at this plant to block cars with long pieces of wood. This workman in placing a block, did so in such a manner that when the block slipped, he fell in after it and was run over by the car. Ill. 10 shows the right and wrong methods of blocking a car.

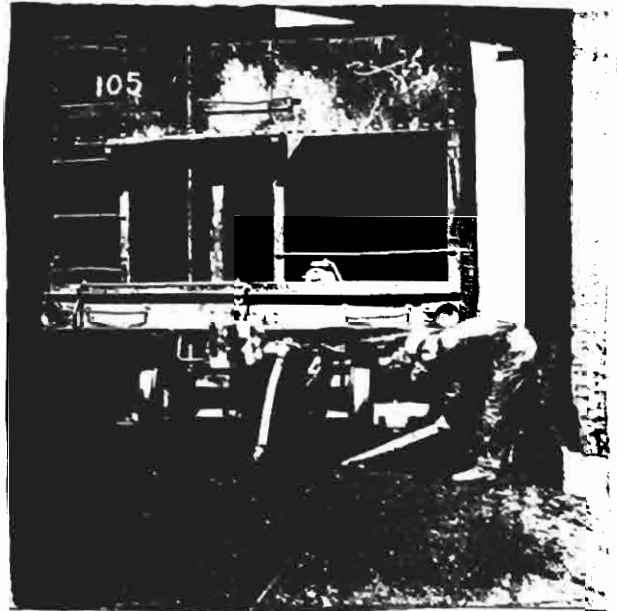
Gantry Cranes and Docks.

There are a great many cement plants situated on

navigable waters and in these instances considerable coal will be brought in and cement shipped out by boat. In handling coal from the boats, gantry cranes are quite often used. Here there is danger from men having to go into the hold of the boat to clean up, and being caught between the side of the vessel and the bucket.



The Right Way



The Wrong Way.

Illustration 10.

Heavy Repair Parts.

There are a great many large and heavy repair parts for cement machinery which have to be handled by the repair gang. Here the hazards are in the men themselves not being careful, and in not having adequate or safe rigging apparatus, such as chain blocks, rope blocks, chains, ropes and slings.

Teaming.

A great deal of material^{is} transported around the plant by means of wagons and carts, but the chief dangers here exist in the loading and unloading of same.

Handling Material by Hand.

Many minor injuries to hands and feet and some very serious ones are caused by handling material by hand. Hand trucking, slovenly piling of material, dropping material being carried, strains due to improper lifting etc., all contribute their share to the accident roll, but can generally be counteracted by the education of the workmen.

Hand Tools.

By this term we include hand hammers, sledges, coldcuts, chisels, crowbars, drills, wrenches etc.. A great many accidents have happened on account of handles breaking, improper use of tools, heads not securely fastened, and allowing heads to become burred or mushroomed. These hazards can be largely overcome by proper inspection and the installation of tool rooms.

Falling Material.

Platforms, unless provided with toe boards, are always a source of accident, from material, tools etc., getting kicked off and falling on men below. Men working in elevated places often drop material and tools, and unless provision has been made to prevent it material will fall from overhead conveyors.

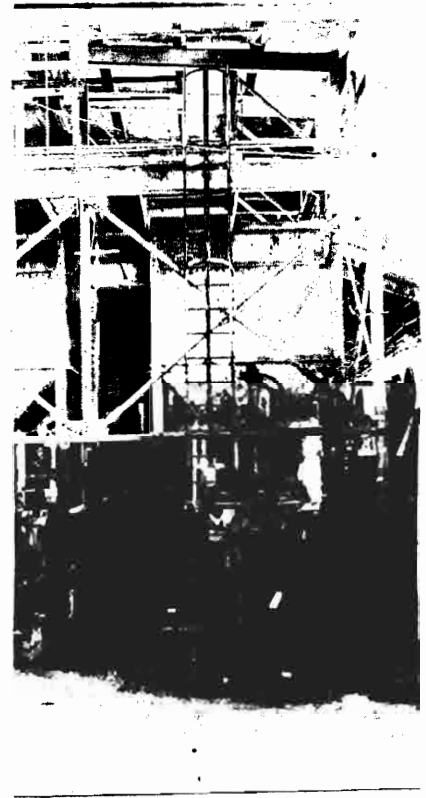
Falls.

As there are machines at many elevations in a cement mill, there is great danger of men falling while going up and down stairs and ladders. To prevent this all stairs must be provided with proper hand rails,

(Ill. 11), and all ladders, if of any height, must be caged (Ill. 12). All passageways if allowed to collect material will constitute tripping and stumbling hazards.



Illustration 11



Boilers. Engines. Air Compressors.

Boilers.

A good many cement plants receive their power from outside sources, others generate their power in their own power houses, while there are mills still operating by means of line shafting,

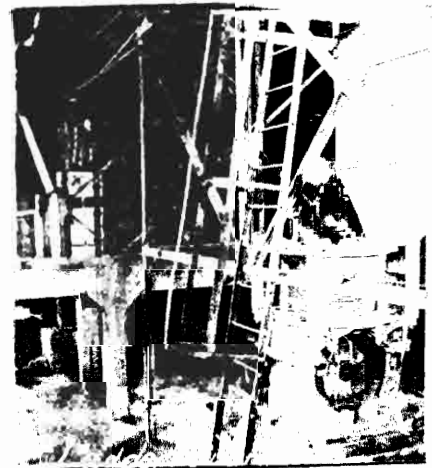


Illustration 12.

power being transmitted from a central engine room. In addition to the boilers in the power plants, there are boilers on locomotives, steam shovels, locomotive cranes, hoists etc.. Most companies have their boilers inspected at regular intervals by government or insurance inspectors,

so that assurance is given that the boilers are in good condition. If in addition to this, only authorized firemen are employed, a good many of the hazards connected with boilers have been overcome. However constant attention must be given to steam gauges, water glasses, feed water regulators, valves and stems etc., to see that they are always in good condition.

Engines.

In spite of the many dangers that can be overcome by mechanical guarding and carefulness in oiling, the engine room is nevertheless considered very hazardous. The fly wheels must be operated at safe speeds to avoid explosions. Careful and frequent inspections must be made of all governors and other regulating parts. Precautions must be taken to prevent the blowing out of cylinder heads. Great care must be exercised in starting and shutting down engines.

Air Compressors.

Compressed air is used to a considerable extent in cement plants, not only for operating the air drills in the quarry but thruout the plant generally for pneumatic tools, forges agitators etc.. The liability of explosions in air compressors and receivers demands very careful attention. Air compressors usually have extremely variable loads. A good many explosions are caused by the lubricating oil used in the air cylinder. It is advisable to keep the temperature of the compressed air during compression, as low as possible. All receivers

must be equipped with pressure gauges. (Detailed information regarding the Safe operation of Boilers, Engines and Air Compressors will be found in Safe Practice Pamphlets, #9, 47 and 49 issued by the National Safety Council, 168 N. Michigan Ave, Chicago.)

Transmission Machinery.

By this term we include all shafting, gearing, pulleys, belts, sprockets and chains.

Shafting.

Measures should be taken to see that no workman has occasion to come in contact with a revolving shaft. Often it is necessary to build walkways over a shaft. (see illustration 13.). All couplings, collars, set-screws, keys, keyways etc. should be covered if there is any danger of men coming in contact with them, otherwise they are liable to catch the men's clothing. Set screws with projecting heads should never be used. Use only Safety Set Screws and Safety Collars. There should be no projecting ends of shafts. Cases have been known where men have been caught on perfectly smooth shafting,
 Shafting
 ^ supported off the floor by floor stands, must be completely enclosed by railings. All bearings must be made accessible to the oiler. Illustration 14 shows a runway for the oiler erected in the roof of a building. If bearings are close to pulleys, couplings etc, the oiler must be protected by a guard. Clutches whether friction, cone or jaw type, offer great hazards and should be guarded. See Illustration 15.

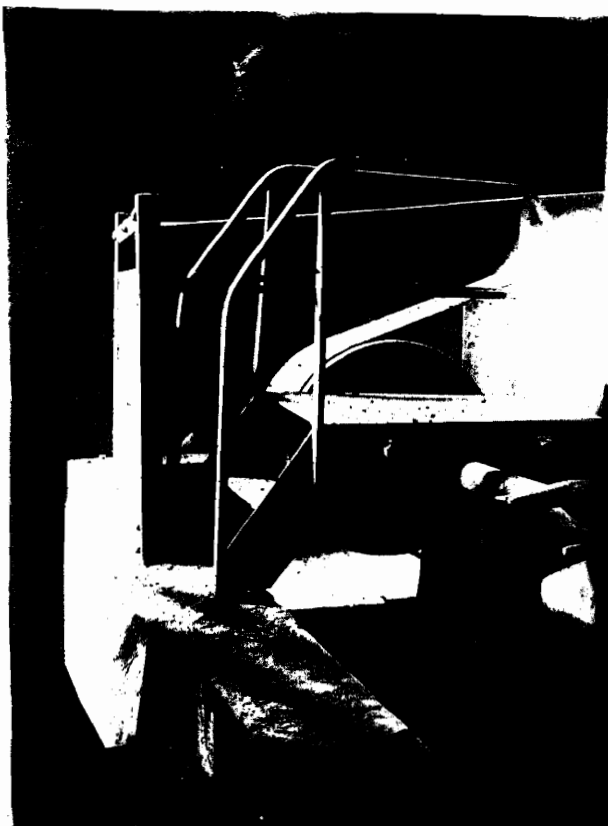


Illustration 13

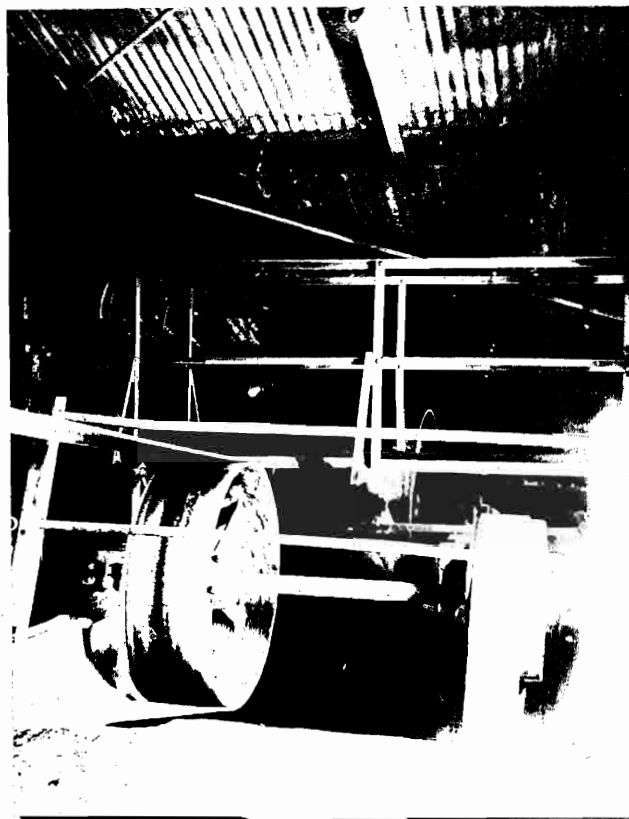


Illustration 14

Pulleys and Belts.

All pulleys should be guarded wherever there is danger of men coming in contact with them. Also all belts. All belts should be guarded where they pass thru a floor(see Ill. 16). All overhead belts should have a guard under them, extending their entire length. The same precautions necessary

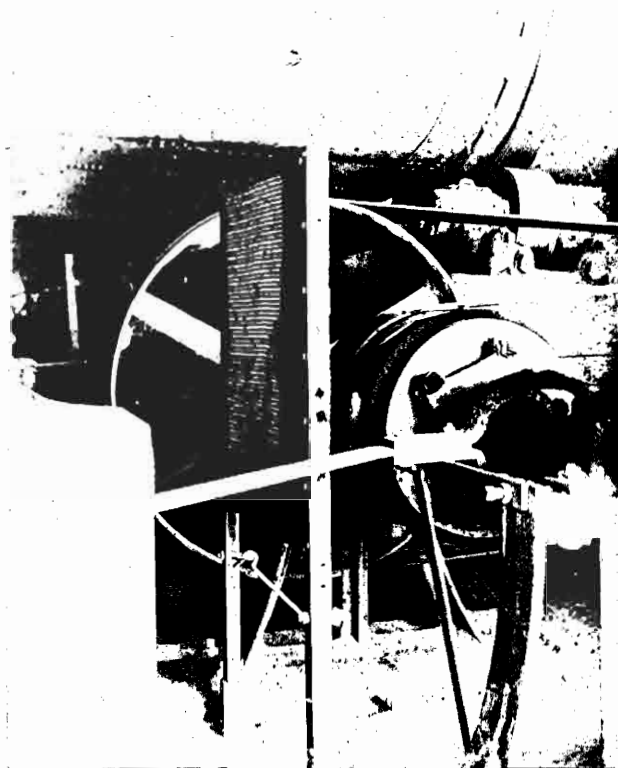


Illustration 15.

for belts are also necessary for chains. Illustrations 17, 18, and 19 show some different types of belt and pulley guards.

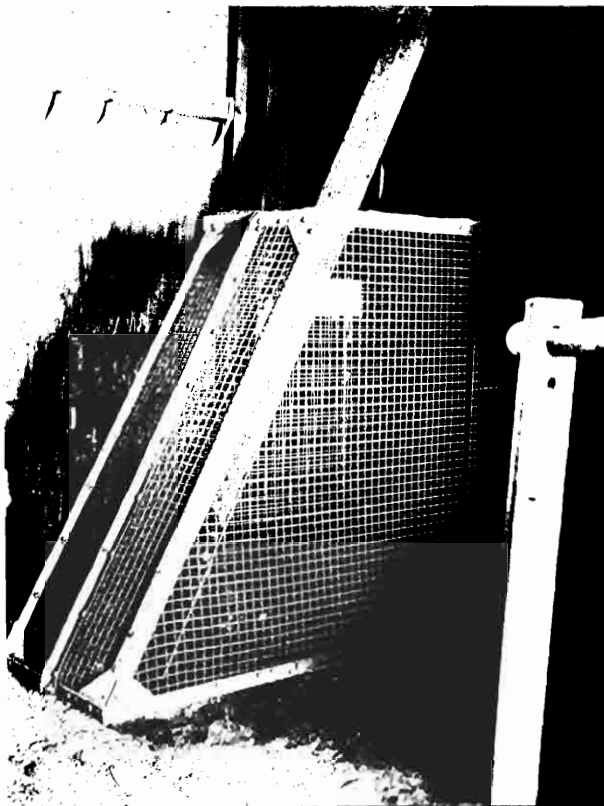


Illustration 16.



Illustration 17.



Illustration 18.



Illustration 19.

Gears. Spur wheels, pinions, bevel wheels, mortice wheels, worm gears, rack and pinions, sprocket wheels etc.. All gearing, regardless of its location should be guarded(usually entirely enclosed). There have been a great many accidents, some fatal caused by men being caught in gearing. On account of the large amount of this gearing in a cement plant, it constitutes a great hazard. Illustrations 20, 21, 22, 23 and 24 show some different types of gear guards.



Illustration 20.

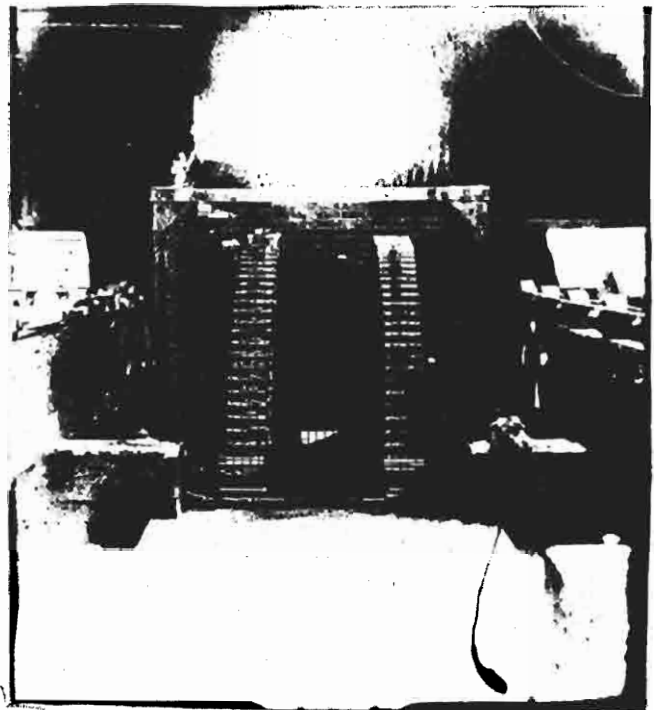


Illustration 21.



Illustration 22



Illustration 23.

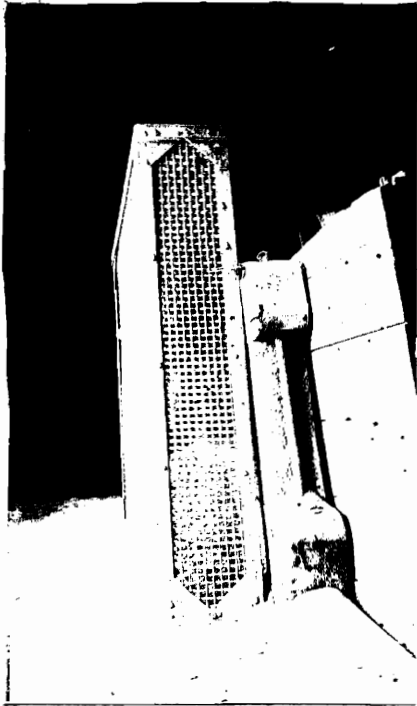


Illustration 24

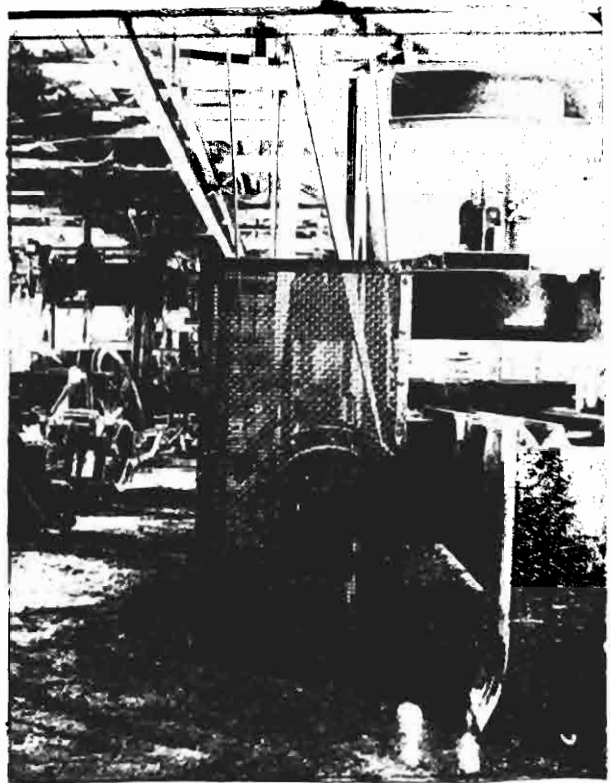


Illustration 25.

Machine Shop.

A cement plant machine shop is a repair and not a production shop, hence there is always more or less congestion of material. Dangers exist here on all the different types of machinery. Planers, drill presses, lathes, boring mills, keyseaters, punches, shears, power hammers etc., have each their own particular hazards which can be largely overcome by guarding. Illustration 25 shows a guarded planer, and Illustration 26 a guarded radial drill.

Abrasion Wheels.

Abrasion wheels require a great deal of attention not only to prevent bursting of the wheel, but to provide protection in case the wheel does burst. Illustration 27 shows a good type of guard for this purpose.



Illustration 26



Illustration 27.

Carpenter Shop.

Most of the hazards in connection with the machinery in the carpenter shop(power saws, planers, drills, etc.) can be taken care of by mechanical guarding. One of the hardest problems to overcome is the habit of men from outside the shop coming in and operating the woodworking machinery with which they are not familiar. This has been the cause of a large number of accidents.

Eye Injuries.

A great many eye injuries occur in a cement plant. By far the great majority of these accidents can be prevented by providing a comfortable goggle and insisting that it be worn. Eye injuries occur at emery wheels, from chipping and cutting steel, concrete etc., and from pieces flying off the heads of burred tools. Then there

is danger of the cement packers getting hot cement in their eyes due to bags(not having been properly inspected) bursting. A cement plant in general is dusty and there are a great many departments where goggles should be worn all the time.

Materials in Piles and Bins.

There is a great deal of material in cement plants stored in bulk in bins, piles and storages, namely rock, clay, gypsum, coal, clinker and cement. In a great many cases it is finely ground material. A great many fatal accidents have occurred by men getting caught by a slide of material. Sometimes they undermine a pile which causes it to topple over on them, other times they will go into a bin alone, and loosen material that is adhering to the sides of the bin. No matter whether men are working in bins, storages or piles, they should never work alone, and should always wear a Safety Belt and rope, one end of which is held by another workman outside the bin or storage, in which case if a workman is caught by a slide he can be pulled out.

Electrical Apparatus.

While a good many plants generate their own power, there are others that purchase their power from outside. In the latter case the power comes into the plant at a very high voltage(44,000 Volts or more) and great precaution must be maintained in the substation and in preventing the men from coming in contact with the high tension wires. All wiring thruout the plant must be very good, Conduit should be used as much as possible. All motors

must be properly grounded. All switches should be of the enclosed type(safety). All compensators and fuses should be enclosed in boxes. Where motors are located on a different floor than the driving mechanism of the machine, distant control should be provided in the way of push buttons. Starting boxes are sometimes located in wet or damp places. In these instances rubber mats or wood slats should be provided for the men to stand on, to prevent grounding thru the operator. There is always great danger in starting and stopping motors unless this is done by experienced men. Certain men in each department should be authorized to start and stop motors and all others should be prohibited from so doing. Many accidents are caused by men pulling switches to stop motors. This always causes an arc and should never be allowed. In the modern cement plant, each machine has it's individual motor. While this condition really tends to make the mill safer, the large number of motors, require the services of a competent electrical inspector, who does nothing else but inspect electrical apparatus and sees that it is all kept in good condition. Great precaution should be taken before working on any line, to see that the line is open and that there will be no chance of its being closed while the work is going on.

Lighting.

In general the better the mill is lighted, the fewer accidents there will be. Dark corners are breeders of accidents.

Coal Dust.

Nearly all finely divided organic or metallic

substances are liable to explode when mixed with air and ignited. This is particularly true of coal dust. The general treatment of coal for cement byrning, is drying and pulverizing until 95% will pass a 200 mesh screen. A coal drying and pulverizing department will necessarily have many conveyors and elevators. These elevators and conveyors must be made dust tight. Keep the coal department clean. Provide plenty of ventilation. There must be no open lights or fires. Do not allow the coal^{dust} to accumulate on floors, in corners or on roof trusses. The coal dust should be swept down every day, but the mills should be shut down during this operation. All motors should be enclosed in separate rooms outside the mill building. Dust collection systems are being installed in some of the cement plants at the present time. Never stop a coal dryer while it contains a charge of coal. Do not allow any powdered coal to remain for any length of time in bins and tanks. In case of fires, which are quite a possibility, provision must be made in the way of fire escapes, outside the building, so that no men will be trapped in the top parts of the building. Too much attention cannot be given the coal department as the cement industry has contributed many fatal accidents from coal explosions and fires. Illustration 28. shows a very clean coal mill, but it also shows a motor in the same building with the rest of the machines which is not Safety Practice.

Housekeeping.

The cleaner the mill is kept, the less liability of accidents. It is sometimes very hard to keep the yard

clean, as in cleaning up the mill buildings, refuse is thrown in the yard. But by providing proper scrap piles, dumps and refuse boxes a cement plant can be kept as neat as a plant of any other industry. Providing good walks around the plant, from department to department, makes easier the moving of materials and lessens the liability of accident.

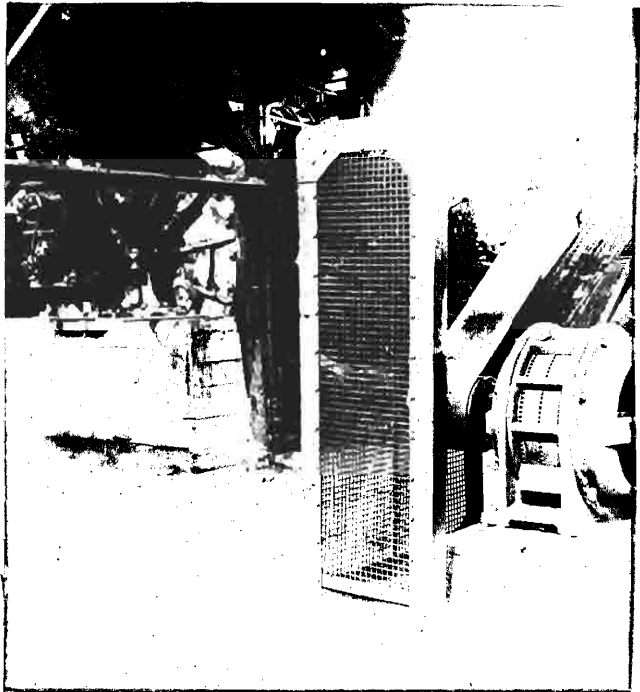


Illustration 28.

Construction.

In order to keep pace with the advances in cement manufacture there is always a certain amount of construction work going on. The Safety Organization must be extended to include this construction and precautions taken to see that the scaffolding is erected in a safe manner. Many accidents have happened in construction on account of too hurried methods being used in making temporary platforms etc.

Infection.

A great deal of lost time in the cement industry

is due to infection. In any industry there are necessarily a great many small cuts and scratches occurring every day. If these minor injuries are not attended to immediately at the first aid department, a large



Illustration 29.

number of them develop into infections, with their consequent loss of fingers, limbs and even life. Ill. 29 shows an infected thumb, three weeks after it had been scratched with a piece of sheet iron. Eventually the thumb had to be amputated.

Starting machinery which has been shut down for repairs.

A great many deplorable accidents have occurred by machinery being started up while men are at work on it. To prevent this, no man should be allowed to work on any machine, unless he has placed a lock on the switch or clutch of the machine and carries the key in his own pocket.

These are by no means all the hazards which are prevalent in a cement plant, but they cover in a general way, some of the most common ones.

The Prevention of Accidents.Safety Organization.

From the records of companies which have been carrying safety organizations for the past 18 years, it has been conclusively shown that safety work, pays financially.

Management.

Safety organization starts from the manager. If the manager is thoroughly determined to prevent accidents in his organization and shows a sincere interest in the work at all times, then excellent results can be accomplished. If however he shows only half hearted interest, it will be reflected thruout the entire organization, by the attitude of his men. He must convince his men that the company is willing to do its part. He can do this by providing mechanical guards, good lighting of the mills, and by supplying good sanitary conditions in the plants.

Safety Engineer.

Generally in a cement plant, the safety engineer besides having charge of the safety work, will have charge of all the employees relations, which include employment, first aid, sanitation and welfare. Besides having a technical education, he should be persistent, sympathetic, initiative and a leader.

Foremen and Sub foremen.

The foremen have a very important place in the organization. Unless they are convinced that accident prevention is a necessary procedure in the manufacture of cement and not just a passing hobby, they will be a detriment to good safety work. When however, they

are thoroughly interested, they become one of the most powerful agents that the safety engineer can employ. Frequent meetings of the foremen should be held, at which they will be addressed by the manager and the safety engineer. At these meetings suggestions will be exchanged and eventually a fine spirit of co-operation will be established. The safety engineer should frequently provide the foremen with charts showing the standing of the different departments, comparisons of different plants and different companies. He should make a frequent inspection of a department with the departmental foreman, and together check up the hazards and make recommendations. He should use any other originalities that will tend to keep the foremen keenly interested.

Safety Committees.

There are a great many systems of forming safety committees, employed in cement plants. A method in very general use, is that of having a central committee. This central committee holds regular meetings, passes on all suggestions received and makes recommendations. Generally this committee is composed of the superintendent, safety engineer and several other men, usually foremen. In addition to this central committee, workmen's committees are appointed in the different departments. By appointing a workman on a committee, you have secured his interest. The general duties of the workmen's committees are to warn fellow workmen regarding unsafe practices, make suggestions, inspections of their own department and to

report on accidents. At one plant a method of having every man in the plant a committeeman, was employed with very good results. This plant employs about 400 men. Every workman was brought into a committee meeting at least once every month. At these meetings the men were addressed by the superintendent and the safety engineer and were asked to make suggestions for making the plant safer.

The main object of the committees is to keep the men interested, and as long as the desired result is accomplished it does not matter about the method employed.

Mechanical Guarding.

It is estimated that only a small percentage of the accidents can be prevented by mechanical guarding. However guards are absolutely necessary and unless they are put up, only poor results in accident reduction can be expected. Guarding is endless. New guards are constantly required and it takes a considerable amount of work to keep the old guards in good repair. It will pay any cement plant to have a well equipped guard shop. Guards can be constructed of many different kinds of material; angle iron, pipe, expanded metal, sheet iron, woven wire, perforated metal etc.. Illustrations 30 to 35 inclusive show guards constructed of various materials. In general guards must afford maximum protection; they must be strong enough to stand the abuse of handling in addition to the regular wear and tear; they must not interfere with the operation of the machine; they must be made no heavier nor clumsier than possible on account

of having to move them about; they must be constructed so that they will not interfere with the repairs and lubrication to the enclosed parts. In order that a guard will comply with all these requisites, a great deal of attention should be given to its design.

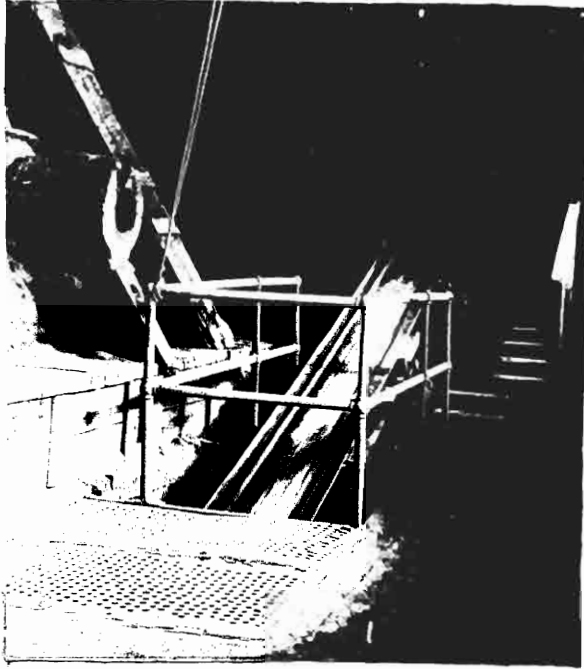


Illustration 30.
Guard of pipe.
Perforated floor plates.



Illustration 31.
Belt guard of angle
Iron.



Illustration 32.
Belt guard of 1 1/2"
Pipe.

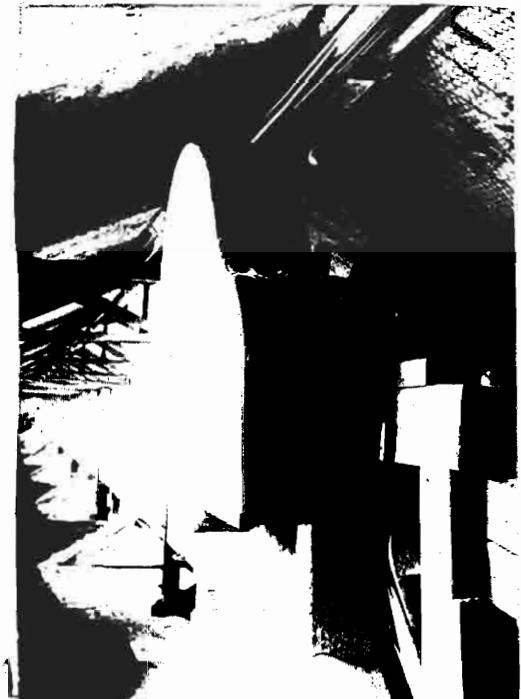


Illustration 33
Gear guard of #12 iron



Illustration 34.
Woven wire and angle iron
pulley guards.



Illustration 35
Angle iron and plate
Pulley guard.

Education.

It is often said that 70% of all accidents are accountable to the human element. The only way to attack the hazards due to the human element is by the education of the workman. One of these methods^{as} I have already pointed out is by workmen's safety committees.

Bulletins.

The bulletin board plays a very important part in the educational campaign. Bulletin boards should be placed in plant entrances and in every department, so that all of the men will be confronted with them daily. The boards should be well built and attractive. Illuminated bulletin boards are very effective. In order to keep the interest of the men alive, the bulletins should be changed very frequently, and should be made as attractive and interesting as possible. Material for bulletins

is supplied by charts, accident records, photographs, blue prints, stories of accidents, safe methods of working, newspaper clippings, cartoons, slogans etc.. Bulletins can be purchased from the National Safety Council and other organizations but these should be supplemented by home made bulletins. The workman appreciates the effort that has been expended in home made bulletins and reads them attentively. Where there are many foreign workmen employed bulletins should be posted in all the different languages. Any method of attracting workmen to the bulletin boards is permissible, the more original the method the better. One very effective way of advertising safety, is to enclose a small safety bulletin in each workman's pay envelope.

Competitions and Special Campaigns.

Competitions and special campaigns have been productive of very astonishing results in cement plant accident prevention. These special campaigns have an object in view, namely some specified period of time, during which a plant strives to have no lost time accidents. During this period, special and novel forms of advertising are used and special attention is given to this campaign by the plant officials. Records from these special campaigns show that nearly all plants having conducted them, have made an improvement in their past accident record, even tho they have not accomplished their objective.

Competitions may be held between different departments of a plant, different plants of a company and different companies of an industry. The Portland Cement Asso-

ciation hold a competition each year; the cement plant having the best accident record for the year is awarded with a large silver trophy.

Companies operating more than one plant, usually award the plant having the best accident record for the year with a trophy or pennant.

Awards can be made in interdepartmental competitions by cash prizes, holidays, badges, pennants etc. Illustrations 36 and 37 show two large boards which were used for scoring in an interdepartmental competition.

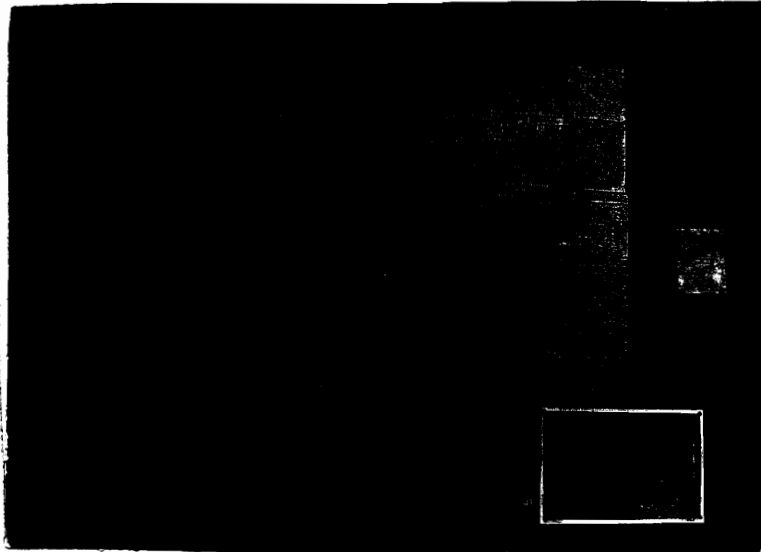


Illustration 36

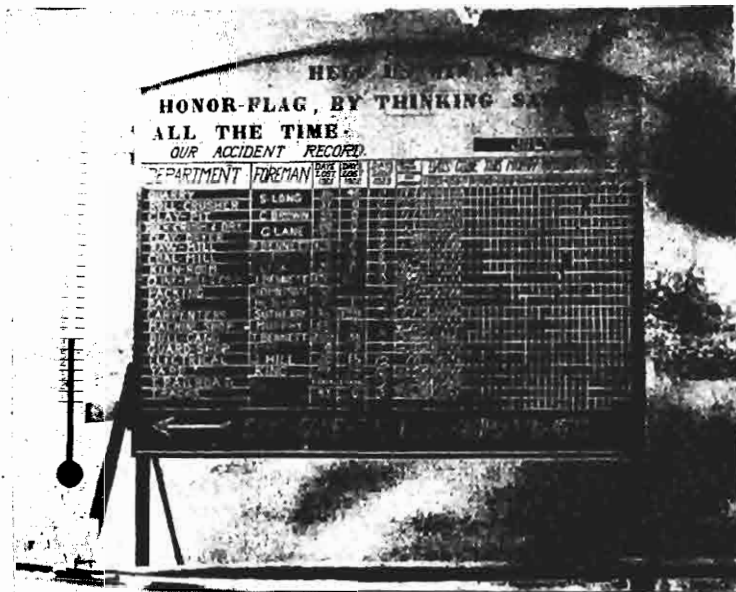


Illustration 37.

Suggestions.

If the workman is encouraged to turn in suggestions, he will take an active interest in safety work. Suggestions are solicited from workmen on safety, efficiency and general improvements. Experience of companies using the suggestion system show that about 90% of all the suggestions received are practicable. Acknowledgement by letter should be made of all suggestions received.

Signs.

Warning signs should be distributed very generously around a cement mill. They should only be put up where dangers really exist and should explain if possible the nature of the danger. These warning signs should be kept clean and renewed when they begin to show signs of wear. Illustration 38, shows 2 home made warning signs that were used in a cement plant.



Illustration 38.

The New Man.

Accidents often happen to new employees, because they are doing work with which they are not familiar, and the dangers of which they do not understand. To overcome this tendency, the new employee should undergo a physical examination, and be placed in a department for which he is best suited. At one plant after undergoing the physical examination, the new employee is given a letter from the superintendent, explaining the purposes and methods of the safety work, and asking for the cooperation of the new employee. He is then given a rule book, prepared by the company, stating the safe methods of operation and the hazards with which he is likely to meet. This system has reduced materially, the liability of accident to the new employee.

Plant and Company Publications.

A great many cement companies get out monthly bulletins. These bulletins are always made as interesting as possible and a good portion of them is always devoted to accident prevention. The different companies publishing these bulletins have found that they are very well received by the employees.

Letters.

Very good results can be accomplished by sending out circular letters, signed by the manager or safety engineer, to every employee in the plant. This is usually done during special drives, at Christmas time when giving out safety calendars, etc.

Engineering in regard to new installations.

In cement plants a great many new buildings are constructed, alterations made and new equipment and machines installed without the plans and specifications having been checked by the safety engineer. This is a great waste of money as it necessitates much work in the way of providing guards for the new machinery, and often changes to the building itself. It also causes many hazardous conditions to occur that can not be changed later at any cost. Engineering revision removes the bad accident causes and has been responsible for the most outstanding advances in safety work. It produces maximum safety at a minimum cost. So it is important that all plans and specifications be checked by a competent safety engineer before any purchases are made or alteration or construction work started.

Accident Records.

Successful accident prevention work is based on actual accident experience. So it is necessary that every accident be thoroughly investigated and a complete report made of the investigation. Accident records to be of any practical value, must include the complete history of the accident from the time the accident occurs until the injured person is back at work or the case otherwise adjusted or closed. A daily record of all minor injuries should be kept. Good accident records provide a wonderful source of information from which the safety engineer can devise preventative measures. He can classify the accidents according to causes and then

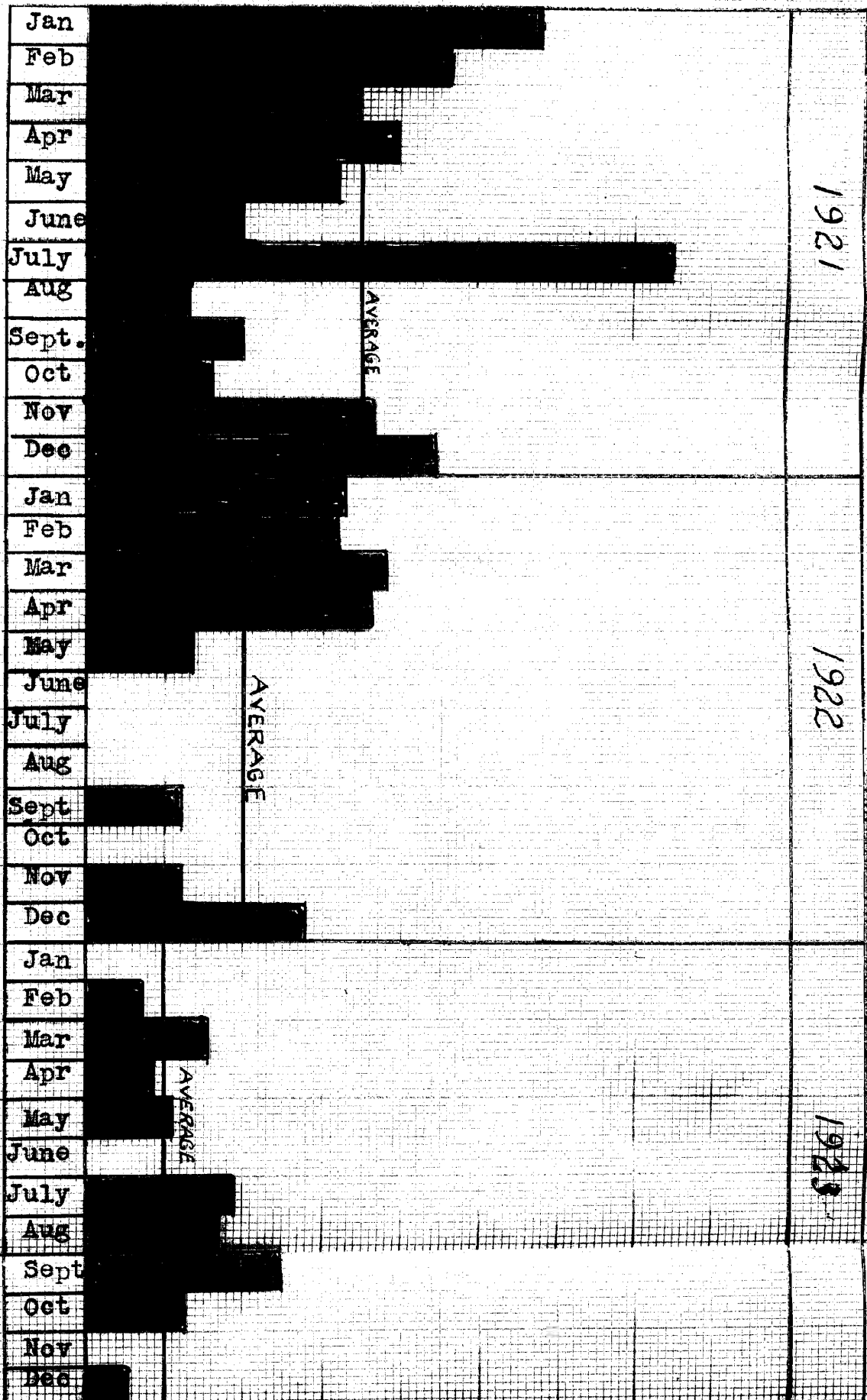
devote his attention to removing the causes. He can prepare charts showing the improvement in the plant record, which he can use on bulletin boards and also in keeping the management advised as to the plant's standing. There are limitless curves and charts that can be prepared showing the savings in dollars, loss of life, lost time, etc., and they all have a very great influence on the accident prevention campaign. Charts I and II show the accident frequency and the severity rates at one plant for the years 1921, 1922 and 1923. These charts were prepared for bulletin board use to show the employees how their plant was progressing.

First Aid.

First aid is a necessary branch of every cement plant. The size and equipment of the first aid hospital depends on the number of men employed. Some of the larger plants have completely equipped hospitals with a trained nurse in attendance day and night, and a doctor present for certain hours every day. In some of the smaller plants a small room is provided for first aid which is rendered by some employee who has other duties to perform also. Most cement plants which do not have completely equipped hospitals, are provided with motor ambulances for conveying the injured workman to the nearest hospital in the shortest possible time. Some of the larger plants employ visiting nurses, particularly the plants located in small villages. These nurses visit the employees families and advise them on health matters. Sometimes the doctor holds a clinic 3 or 4

Frequency. Accidents per 100,000 Hours. Chart I.

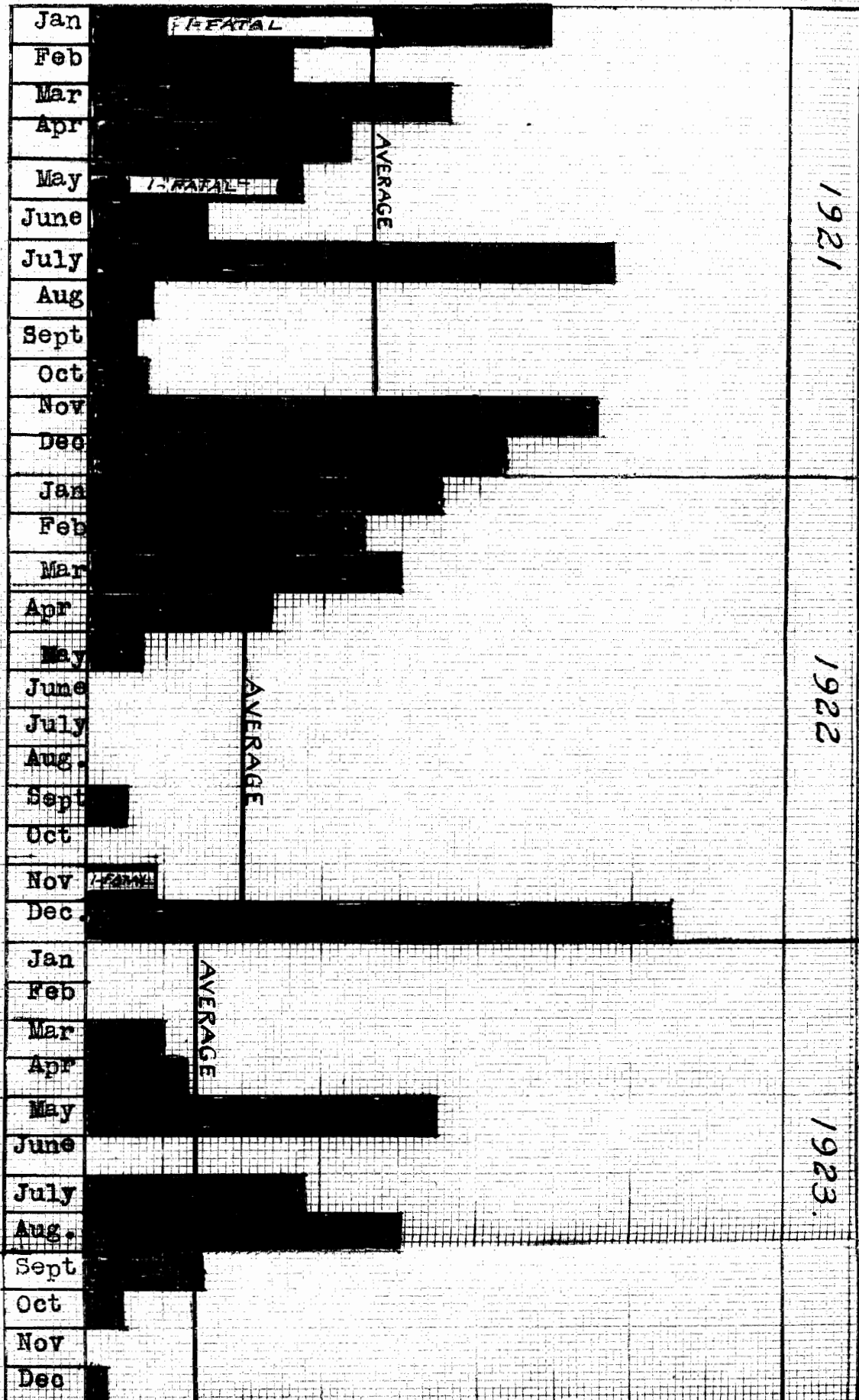
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15



SEVERITY. Days lost per 100,000 Hours.

Chart II.

0 40 80 120 160 200 240 280 320



times a week which is free to employees. In a few cases companies have provided free dental service. No matter in what way a first aid hospital is conducted, the main object is to attend promptly to all serious and minor injuries. The easier and more attractive it is made for the men, the better will be the results that it will accomplish. Some companies conduct first aid classes and hold first aid competitions. This is a very good practice and not only insures the organization an abundant supply of men capable of performing efficient first aid, but it has been shown that the men trained in first aid are almost always a great benefit to the safety organization. Whether first aid classes are conducted or not, it is advisable to have as large a number of men as possible, able to apply the prone pressure method of artificial respiration. Many lives have been saved in the cement industry, in cases of electric shock, gasing and smothering, due to the fact that men were present who were familiar with this method. Illustration 39 shows a corner of a cement plant first aid hospital.

Sanitation, Social Life and Athletics.

Until a few years ago, sanitary conditions were not much thought of in a cement plant. Today however most companies have realized the importance of sanitation and have provided adequate wash rooms, toilets, baths and an abundance of good drinking water. It has been found from experience that in order to operate wash and toilet rooms successfully, it is necessary to have an attendant constantly in charge, who sees that they are

maintained in the proper manner. The fact of maintaining these conveniences for the men, has attracted a better class of workman to the plant, which has been a big factor, not only in the furthurance of accident prevention but in the general plant efficiency.

Athletics and social activities tend to keep the employees happy and contented and cuts down the cost of labor turnover. Many companies have taken up this branch of activity very extensively. Illustration 40, shows an interior view of one cement company's club house. Where plants are located in small communities, cement companies have provided comfortable and attractive houses for their workmen.

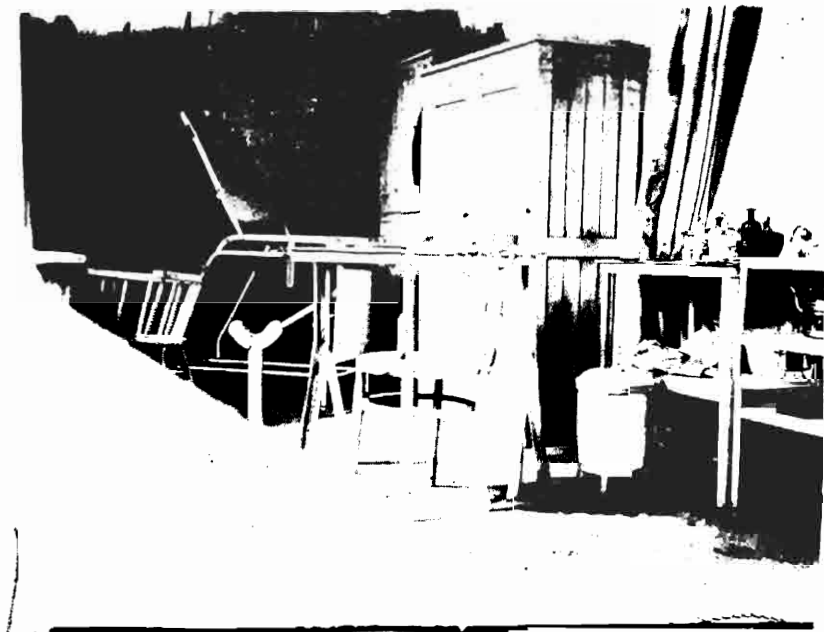


Illustration 39.



Illustration 40.

Conclusion.

While this paper has treated in a general way, the hazards found and the methods of prevention used in a cement plant there must necessarily be a great many phases of this subject which have not been touched. In general, all accidents are caused by the failure of men, methods or materials and only by the overcoming of these failures will the condition sought for, no accidents, be approached.

All photographs used in this paper were taken by the writer in plants of the Canada Cement Company Ltd., Montreal, Quebec.

Safety Organizations.

The National Safety Council.
166 N. Michigan Ave, Chicago.

The American Society of Safety Engineers,
29 W. 39th St. New York City.

The Portland Cement Association,
111 W. Washington St., Chicago.

Safety Publications.

The National Safety News(monthly).
Published by the National Safety Council.

Safety Engineering(monthly)
Official transactions of the American Society
of Safety Engineers.

Accident Prevention Bulletin(bi monthly).
Published by the Portland Cement Association.

Proceedings of the National Safety Council.(yearly)
Published by the National Safety Council.

Industrial Accident Prevention, by D.S. Beyer.
Houghton Mifflin Co.

Universal Safety Standards, by Carl M. Hansen
Universal Safety Standards Publishing Co.

Safety, by W.H. Tolman.
Harper & Brothers.