

TRANSACTIONS

29th NATIONAL SAFETY CONGRESS



GENERAL AND INDUSTRIAL
SESSIONS

CHICAGO
OCTOBER 7-11, 1940



NATIONAL SAFETY COUNCIL, INC.
20 North Wacker Drive, Chicago

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PLAINTIFF'S EXHIBIT

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Foreword

THE Transactions of the 29th National Safety Congress and Exposition of the National Safety Council, October 7-11, 1940, are published in two volumes. Volume I contains the General Sessions and the meetings of the various Industrial Sections of the Council. Volume II contains the Street and Highway Traffic, the Commercial Vehicle, the Transit, the Child Education and the Home Safety Sessions.

Volume I is distributed automatically to all industrial members of the Council. Volume II is sent to members who are believed to be interested chiefly in the sessions it contains. However, other members of the Council may obtain Volume II upon request.

Many Council members have found it advantageous to distribute copies of the Transactions Volumes to the individual executives, foremen and supervisors of their organizations, who make use of the practical safety information the volumes contain to organize accident prevention programs. The volumes contain a vast amount of standard reference material. Extra copies of the Transactions may be obtained as follows: Volume I, one to 10 copies at \$2 each; 11 or more copies \$1.75 each. Extra copies of Volume II may be had at 75 cents each.

THE Transactions are a condensed record of the proceedings of the Congress. The papers and addresses and many of the discussions have been edited to delete extraneous matter, abbreviate the less important portions, and emphasize those parts of particular usefulness in promoting effective safety organization and other accident prevention measures. The volumes are, therefore, a somewhat abridged version, compact, practical, and of particular value to the student, the supervisor and the executive in achieving more thorough accident prevention success. The original manuscripts are available for additional reference, if desired, in the files of the National Safety Council.

THE National Safety Council, at its Congresses, seeks to eliminate from discussion matters which are not pertinent to the aims of the Congress or which may be contrary to the Council's policies. However, it cannot accept responsibility for all the views expressed either in the papers presented or in the discussions based upon these papers.

NATIONAL SAFETY COUNCIL, Inc.
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Contents

Council Officers and Directors.....	4
Council Purposes and Program.....	9
Annual Meeting of Members.....	11
Annual Banquet	27
General Subject Sessions—	
Agricultural Safety	29
Building Maintenance.....	47
Eye Protection	63
Fire Control and Prevention.....	79
Fundamental Causes of Accidents.....	91
Governmental Safety Service in Industry.....	107
Health Service in Industry	119
Industrial Nursing	129
Maintaining Interest in Safety	151
Occupational Disease	165
Off-the-Job Accidents	183
Plant Transportation	197
Psychology and Safety (Early Morning Classes)	209
Safety Belts	245
Safety Supervisors	253
Safety Training	261
Visual Education	277
Aeronautical Section	285
A.S.S.E.—Engineering Section	301
Automotive and Machine Shop Section.....	305
Cement and Quarry Section.....	319
Chemical Section	327
Construction Section	353
Food Section	375
Marine Section	397
Meat Packing, Tanning and Leather Industries Section	427
Metals Section	445
Mining Section	497
Paper and Pulp Section.....	549
Petroleum Section	591
Power Press Section.....	625
Public Utilities Section.....	635
Refrigeration Section	659
Rubber Section	671
Steam Railroad Section.....	697
Textile Section	723
Wood Products Section.....	739
Safety Exposition Exhibitors.....	743
Index	749

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Council Purposes and Program

The National Safety Council is a non-profit, cooperative association whose objective is the elimination of accidents. To achieve this objective the Council advocates the following program of safety activities:

1. Creating Interest in Safety. People will try to prevent accidents only when they are convinced of three things: (a) that accidents are really a serious problem, threatening personal happiness, industrial efficiency and economic security; (b) that accidents don't "just happen," but that each one has definite, ascertainable causes; (c) that accidents can be prevented. The basic requirement in a national safety program, therefore, is a dramatic and effective presentation of these facts to more and more people.

2. Finding Accident Causes. Accident causes are not the same in any two plants, in any two cities, in any two schools. They are not the same from one time to another. Every industrial plant, every city, every school and every other public or private organization, therefore, must study the causes of accidents in its own group, so that prevention efforts always will be directed at the things really responsible for accidents.

3. Maintaining Interest in Safety. People retain interest in very few things of which they are not continuously reminded. Therefore, it is the task of the newspaper, the radio, the magazine, the school, the public speaker and every other educational influence to keep reminding the worker, the driver, the pedestrian, the housewife and the school child that freedom from accidents depends on personal caution, and that the safe way is the right way and the best way—from the standpoint not only of human satisfaction, but of social efficiency and economy.

4. Engineering Improvement. Many accidents occur because equipment is faulty. The punch press is unguarded, the auto-

mobile brakes are worn, the stairway is crudely built, the propeller is defective, the stop sign is obscured. The avoidance of accidents, therefore, requires that safety be built into every piece of machinery, every home, every school building, every highway. We must insist that the things we buy—whether a stepladder or a stop sign, a band-saw or a blast furnace—be safe things. And we must be willing if necessary to pay a higher price because of this built-in safety factor, realizing that it is true economy to do so.

5. Training for Safety. Many accidents occur because the injured person or some other person acts in an unsafe manner. This unsafe act often is committed because the person involved never has been taught how to do the job in the safe way. Therefore, boys and girls, men and women, must be taught how to work, how to drive, how to cross the street, how to live safely. This teaching and training is a joint responsibility of industry, of schools and colleges, of governmental groups and of parents in the home.

6. Supervision for Safety. Many who know well the safe method of performing an act nevertheless are involved in accidents because, due to hurry, fatigue, thoughtlessness or some other reason, they do not perform the act in what they know is the safe way. Therefore, we need good foremen in industry, alert patrol boys in our schools, diligent police officers on our streets, thoughtful parents in our homes. These, through wise guidance of those under their supervision, can greatly minimize the chances of accident.

7. Legislation for Safety. Avoidance of accidents requires the adoption and scientific enforcement of sound legislation—legislation on traffic, on industrial matters, on public transportation, on home construction and maintenance, and on many items of per-

the subjects in which courses are given are: shop mathematics, physics, materials and methods of aircraft inspection, C.A.A. rules and regulations, aircraft radio, internal combustion engines, etc.

Each apprentice is at the same time carrying on his regular work schedule in the shops; is assigned to assist a qualified licensed mechanic, and his classroom work does not interfere except to the extent that he is excused from the shops if a class in which he is enrolled is conducted during his work shift.

An apprentice's work assignments are arranged so that the work he is doing at any given time is closely related to the subjects he is studying in class; likewise, the entire training program is set up to provide for an apprentice spending a given number of months in each department of maintenance.

As the program has developed, the problem of selecting capable and dependable persons to place in the apprentice training school has itself become somewhat difficult, because the persons selected must possess the intelligence and mechanical aptitude necessary to master a highly technical craft, as well as the stability, energy, and perseverance to complete a four-year training program. Persons placed in this school who do not have the tenacity to see it through, represent a rather substantial loss in time and money.

Experience has indicated that those applicants who perform best are those who have had at least a high school education with some mechanical training and experience. Further, it is found that those applicants from families mechanically inclined generally prove more satisfactory.

Keeping these things in mind, Braniff Airways carefully selects from the rather large group of young men who apply, those

who seem to possess most completely these qualifications. In a further effort to place only the best in the school, arrangements are made to administer dexterity and manipulatory tests to each of these men in an effort to secure some indication of his true mechanical aptitude and intelligence. These tests are so inclusive and broad in scope that they require eight hours to administer, and were chosen upon the recommendation of experts in vocational guidance and employee selection.

The applicants finally selected are employed as stockrunners or cleaners, where they have the opportunity to familiarize themselves with the various airplane and engine parts. They serve in that capacity generally for 10 or 12 months, at which time they are placed in the apprentice mechanics' training school.

All shop supervisors who have apprentice mechanics working under them, make a periodic report to the supervisor of apprentices and the Apprentice Committee concerning the apprentice's rating on appearance, cooperation, conduct, health, initiative, quality of work, ability, and desire to learn and actual performance.

Throughout the entire four-year training program, the apprentice is taught theory and principle in the classroom and has practical instruction and experience in the shops. Though Braniff Airways has found that this method of selecting and training potential mechanics requires a considerable amount of time and some expense at the outset, it has likewise found that the persons so selected possess the necessary qualifications to capitalize on this extensive training program and that in the long run, a considerable amount of time and money is saved and a more highly capable airplane mechanic is generally produced.

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TUESDAY EVENING SESSION

October 8, 1940

The Annual Meeting of the A.S.S.E.—Engineering Section of the National Safety Council convened with F. W. Braun, Employers Mutuals, Wausau, Wisconsin, Gen-

eral Chairman, presiding. All reports have been mimeographed and copies were available at the meeting.

Mr. Braun gave a brief resume of the section's activities during the past year, following which he called up Mr. C. B. Boulet for the report of the Nominating Committee. Mr. Boulet presented the report on behalf of other members of the committee, including R. E. Donovan, Chairman; D. L. Royer, C. W. Smith, and A. S. Regula. The committee's list of officers, as elected, is presented elsewhere in these pages.

The General Chairman then presented the speaker of the evening, Dr. Phillips Thomas, Research Engineer, Westinghouse Electric & Manufacturing Co., who spoke on "New Horizons of Science," demonstrating and illustrating his address most effectively. The resume given below is a summary of his points, provided for this record by the publicity department of the Westinghouse organization.

New Horizons of Science

By DR. PHILLIPS THOMAS

Research Engineer, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Death rays that protect life and laboratory tools that guard against mechanical defects have demonstrated that industrial research is building a safer world on this side of the Atlantic and is helping defend our gains.

Dr. Thomas used a one-man traveling laboratory to buttress his assertion that peacetime research is a major defense line in the American pattern of life. "Many recent developments of the laboratories," he said, "are so closely related to military defense that they cannot be revealed, but it can be said that practically every important peacetime engineering achievement of the past 10 years will have an important, if indirect, bearing on our national defense, enabling this country to build stronger and better designed defense weapons."

Death Ray Guards Health

Dr. Thomas flashed upon a screen a magnified view of ultraviolet radiation in action killing teeming microscopic life in a drop of water. Striking faster than lightning, the radiation literally exploded its victims.

At one moment, onlookers saw swarms of tiny ovate organisms known as paramecia, scurrying across the lighted screen. Then, with a sharp report, a "Sterilamp" hurled ultraviolet radiation at the organisms. In less than a thousandth of the time required to blink an eye, they were dead.

"The Sterilamp," Dr. Thomas explained, "was developed by Westinghouse to produce ultraviolet radiation of a wavelength most

fatal to bacteria." In the demonstration apparatus, electrical energy is stored in a condenser until it jumps across a spark gap with a loud crack. At that instant, the stored up energy is released through a special Sterilamp, concentrating its radiation in one powerful shot.

Sterilamps are now used to reduce infection by killing air-borne bacteria in hospital operating rooms, to preserve the cleanliness of utensils and glasses in restaurants, and to retard mold growth on food. They have made possible a short-cut process in tenderizing beef by controlling mold growth and reducing the aging or ripening time from several weeks to a few days.

Using the rays from a flashlight to play a set of chimes, the lecturer demonstrated a possible means of secret communication over short distances in war maneuvers. In the demonstration, visible light energized photo-electric cells, but he said it would be possible to use invisible infra-red light. Infra-red rays can be made to vary in intensity with the sound waves of a spoken message, transferred invisibly over space, and then reconverted to sound waves at the receiving end, he pointed out.

Atom smashing is another field of research which is already producing peacetime benefits, and may prove to be important in future defense plans. "By constant experimenting," he said, "physicists are learning better to duplicate nature's work and change one element into another. Thus they are able to create new products and processes."

Aeronautical Section

Officers 1939-1940

General Chairman—C. R. SMITH, American Air Lines, Jackson Heights, L. I., N. Y.
Vice-Chairman—MAJOR R. W. SCHROEDER, United Air Lines Transport Corp., Chicago, Ill.
Vice-Chairman—JEROME LEDERER, Civil Aeronautics Board, Washington, D. C.
Secretary—EDWARD T. PAXTON, Pan American Airways, New York, N. Y.

Officers 1940-1941

General Chairman—MAJOR R. W. SCHROEDER, United Air Lines Transport Corp., Chicago, Ill.
Vice-Chairmen—TOM O. HARDIN, Transcontinental & Western Air, Inc., Kansas City, Mo.
JEROME LEDERER, Civil Aeronautics Board, Washington, D. C.
Secretary—EDWARD T. PAXTON, Pan American Airways, Inc., New York, N. Y.

WEDNESDAY AFTERNOON SESSION

October 9, 1940

The session was called to order by Major R. W. Schroeder, Vice-President for Safety, United Air Lines Transport Corporation, Chicago, who presided. After commenting briefly on the objectives of the Congress,

and especially on the participation of the airlines of the country in the nationwide campaign for accident prevention in all industries and pursuits, Major Schroeder introduced the first speaker.

Uniform Airport Traffic Control

By MAJOR JOHN BERRY

Manager, Cleveland Airport, Cleveland, O.

Uniform airport traffic control must of necessity be Federal control.

In 1929 there was installed at the Cleveland Airport, over the objections of the Airlines and the Department of Commerce, a control tower whose primary purpose at that time was to prevent collisions on the airport and to expedite the landing of transports for plane-train connections.

As traffic built up we developed a system for coordinating and distributing information along the airways which centered at Cleveland. A record was kept of the ships on these airways, the altitude at which they

were flying, their destination, arrivals at their terminals and in a limited way carrying out the functions which have since been developed by the Airway Traffic Control Section of the Department of Commerce.

The primary function of an Airport Control Tower is to supply information to the pilots of the various airplanes landing and taking off from an airport. It provides the order in which planes are to take off, whenever such action is necessary, and of necessity determines the question of priority.

The increase in numbers of privately operated airplanes, coupled with student flying

With a model resembling a giant toadstool, Dr. Thomas demonstrated how the 60-foot "atom-smasher" generates its tremendous voltage for bombarding the atom and producing radio-active materials.

A direct current generator provided electrical charges for the miniature "atom smasher" used in this demonstration. These charges were deposited upon an endless belt and carried up the "stem" of the model into a hollow copper dome at the top. The accumulation of charges increased continuously and passed to the outside of the dome, from which they were shot into the air. Dr. Thomas estimated that the model is able to generate 100,000 volts.

Balls Lose Bounce

A recent research development was described as taking the bounce out of electrical relays and reducing wear on electrical control equipment. Dr. Thomas contradicted one of the rules of gravitation by making two steel balls of identical weight and size roll down an incline at different speeds. The research engineer explained that the friction of loosely packed powdered tungsten inside one of the balls absorbed part of its energy of motion, slowed it to a walk. Westinghouse engineers, he said, have used this principle of energy absorption to prevent electrical relays bouncing apart when they are closed.

Magnetism was put to work in another kind of energy control. Vibrations in a nickel rod were damped or silenced as long as the rod was not magnetized. But as soon as Dr. Thomas placed the rod in a magnetic coil and turned on the current, it resounded clearly when struck with a hammer. This phenomenon was explained by the presence in the rod of countless invisible magnetic particles, which are in disarray as long as the rod is unmagnetized. In this state they

offer resistance to vibrations, but when the rod is magnetized these miniature magnets line up in an orderly fashion and let the energy from the hammer blow pass through the rod, causing it to vibrate.

Dr. Thomas next shortened and lengthened a nickel rod by talking through it, converting it into a microphone. He held one end of the rod in his mouth, and as he talked the mechanical force of the sounds changed the rod's length. The amount of magnetism induced in the metal by a permanent magnet surrounding the opposite end of the rod was also changed, generating a sufficient voltage in a small electric coil to "broadcast" Dr. Thomas' words through a loud speaker.

In another spectacular demonstration of a scientific tool now performing important routine work in factories, Dr. Thomas focused the flashing light of a "Stroboglow" lamp on a disc rotating 1,800 times a minute. At this speed, a complicated design painted on the disc appeared to stand still, because the light was timed to flash every revolution of the disc. By doubling the number of flashes of light, Dr. Thomas made two designs appear in place of one. The Stroboglow, he explained, is used in industry to study the operation of rotating machine parts in motion.

Then, to show electricity in a playful mood, Dr. Thomas literally blew out the electric lights—and blew them on again. This, he explained, was not magic, but simply the application of a breath relay. A specially prepared surface on which moisture of the breath is condensed does the trick, providing a partial conductor for a small amount of electrical energy so that currents can flow. This device lights a cold cathode glow tube, which causes a relay to put on the light or turn it off.

ADJOURNMENT

Automotive and Machine Shop Section

Officers 1939-1940

General Chairman—J. C. BOWER, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Vice-Chairman—L. G. SEATON, General Motors Corp., Detroit, Mich.

Secretary—V. I. TROTTER, Plymouth Div., Chrysler Corp., Detroit, Mich.

News Letter Committee—H. B. DUFFUS (*Chairman*), Westinghouse Electric & Manufacturing Co., Springfield, Mass.

W. T. BUCKERIDGE, Nash-Kelvinator Corp., Detroit, Mich.

W. H. MARSHALL, Yellow Truck & Coach Co., Pontiac, Mich.

J. E. MOORE, Cadillac Motor Car Div., General Motors Corp., Detroit, Mich.

Engineering Committee—DAVID MOULD (*Chairman*), General Motors Corp., Detroit, Mich.

R. R. BOZELL, Whitehead & Kales, Ecorse, Mich.

*R. A. SHAW, Murray Corp. of America, Detroit, Mich.

Health Committee—DR. A. L. BROOKS (*Chairman*), Fisher Body Detroit Div., General Motors Corp., Detroit, Mich.

DR. JOHN W. HILBERT, The Studebaker Corp., South Bend, Ind.

DR. S. F. MEEK, Chrysler Corp., Detroit, Mich.

Membership Committee—L. B. LOOMIS (*Chairman*), Ternstedt Manufacturing Div., General Motors Corp., Detroit, Mich.

Poster Committee—L. C. ROBERTS (*Chairman*), Nash-Kelvinator Corp., Detroit, Mich.

EDWARD MANDRY, Truscon Steel Co., Youngstown, Ohio.

MEREDITH SPEAR, A. C. Spark Plug Div., General Motors Corp., Flint, Mich.

Program Committee—C. E. WOOLFEVER (*Chairman*), Buick Motor Div., General Motors Corp., Flint, Mich.

C. W. BISHOP, Lycoming Manufacturing Co., Williamsport, Pa.

C. B. CORNELL, Chrysler Corp., Detroit, Mich.

Publicity Committee—H. A. ZACHARI (*Chairman*), Henry Vogt Machine Co., Louisville, Ky.

ROBERT H. ERWOOD, Budd Wheel Co., Detroit, Mich.

Statistics Committee—OSCAR LEHMAN (*Chairman*), Chrysler Corp., Jefferson Plant, Detroit, Mich.

GEORGE STARLING, Harrison Radiator Corp., Lockport, N. Y.

Members at Large—

*L. E. AVERILL, Chicago Eye Shield Co., Detroit, Mich.

*W. A. BECHILL, Chrysler Corp., De Soto Div., Detroit, Mich.

*M. A. CLARK, U. S. Rubber Co., Detroit, Mich.

*HOYT L. FRACHER, Detroit Steel Products, Detroit, Mich.

*G. A. KUECHENMEISTER, Dominion Forge & Stamping Co., Walkerville, Ont., Canada.

*M. J. MCCARTHY, Fisher Body Detroit Div., General Motors Corp., Detroit, Mich.

*H. L. SAIN, Industrial Commission of Ohio, Columbus, Ohio.

*CARL L. STORCK, Delco Products Div., General Motors Corp., Dayton, Ohio.

*R. F. THALNER, Buick Motor Div., General Motors Corp., Flint, Mich.

*C. T. WINEGAR, Chrysler Corp., Detroit, Mich.

*Past General Chairman

Officers 1940-1941

- General Chairman**—V. I. TROTTER, Plymouth Div., Chrysler Corp., Detroit, Mich.
- Vice-Chairman**—PAUL S. STRECKER, Grand Rapids Stamping Div., General Motors Corp., Grand Rapids, Mich.
- Secretary**—C. E. WOOLFEVER, Buick Motor Div., General Motors Corp., Flint, Mich.
- News Letter Committee**—H. B. DUFFUS (*Chairman*), Westinghouse Electric & Manufacturing Co., Springfield, Mass.
W. T. BUCKERIDGE, Nash-Kelvinator Corp., Detroit, Mich.
W. H. MARSHALL, Yellow Truck & Coach Co., Pontiac, Mich.
- Engineering Committee**—DAVID MOULD (*Chairman*), General Motors Corp., Detroit, Mich.
R. R. BOZELI, Whitehead & Kales Co., Detroit, Mich.
J. E. MOORE, Cadillac Motor Car Div., General Motors Corp., Detroit, Mich.
G. B. TYBRING, International Business Machines Corp., Endicott, N. Y.
- Health Committee**—DR. A. L. BROOKS (*Chairman*), Fisher Body Detroit Div., General Motors Corp., Detroit, Mich.
DR. JOHN W. HILBERT, The Studebaker Corp., South Bend, Ind.
DR. S. F. MEEK, Chrysler Corp., Detroit, Mich.
- Membership Committee**—L. B. LOOMIS (*Chairman*), Ternstedt Mfg. Div., General Motors Corp., Detroit, Mich.
E. E. GREENE, The Timken Roller Bearing Co., Canton, Ohio.
K. N. SEARLES, American Car & Foundry Co., New York, N. Y.
- Poster Committee**—L. C. ROBERTS (*Chairman*), Nash-Kelvinator Corp., Detroit, Mich.
P. V. BAILEY, Remington Rand, Inc., Buffalo, N. Y.
BEN MUNYAN, JR., De Soto Div., Chrysler Corp., Detroit, Mich.
- Program Committee**—O. F. LEHMAN (*Chairman*), Jefferson Plant, Chrysler Corp., Detroit, Mich.
EDWARD MANDRY, Republic Steel Corp., Cleveland, Ohio.
FRANK F. RATHMELL, Westinghouse Electric & Manufacturing Co., Lester, Pa.
MEREDITH SPEAR, A. C. Spark Plug Div., General Motors Corp., Flint, Mich.
- Publicity Committee**—H. A. ZACHAR (*Chairman*), Henry Vogt Machine Co., Louisville, Ky.
GEO. L. EATON, The Singer Manufacturing Co., Bridgeport, Conn.
- Statistics Committee**—C. B. CORNELL (*Chairman*), Chrysler Corp., Detroit, Mich.
ROY P. HATCH, United Shoe Machinery Corp., Beverly, Mass.
GEORGE W. STARLING, Harrison Radiator Div., General Motors Corp., Lockport, N. Y.
- Members at Large**—
*L. E. AVERILL, Chicago Eye Shield Co., Detroit, Mich.
*W. A. BECHILL, Chrysler Corp., De Soto Div., Detroit, Mich.
*J. C. BOWER, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.
*M. A. CLARK, U. S. Rubber Co., Detroit, Mich.
*HOYT L. FRACHER, Detroit Steel Products Co., Detroit, Mich.
*G. A. KUECHENMEISTER, Dominion Forge & Stamping Co., Walkerville, Ont., Canada.
*M. J. MCCARTHY, Fisher Body Detroit Div., General Motors Corp., Detroit, Mich.
*HARRY L. SAIN, Industrial Commission of Ohio, Columbus, Ohio.
*R. A. SHAW, Murray Corp. of America, Detroit, Mich.
*CARL L. STORCK, Delco Products Div., General Motors Corp., Dayton, Ohio.
*R. F. THALNER, Buick Motor Div., General Motors Corp., Flint, Mich.
*C. T. WINEGAR, Chrysler Corp., Detroit, Mich.

*Past General Chairman

WEDNESDAY AFTERNOON SESSION

October 9, 1940

The opening session was called to order by General Chairman J. C. Bower, Supervisor of Safety, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., who presided. The opening remarks of the General Chairman included a welcome to delegates and guests, and dwelt briefly upon the activities of the Section and of

Sectional Committees during the past year.

The report of the Nominating Committee was presented, and officers of the Section for the coming year were formally elected, the list appearing elsewhere in this record. The Chairman then introduced the first speaker.

Specify the Safeguards

By C. THIEDE

Chief Tool Engineer, Chrysler Jefferson Plant, Detroit

For many years we have been stressing the importance of safeguarding the operators of machinery. Although we still have serious accidents I am very glad to say that the number has been greatly reduced, due to the persistent work of the National Safety Council and to the fact that the causes of these serious accidents could easily be traced because the reasons for them were obvious. Great efforts were put forth to reduce these expensive accidents through specifying adequate safeguards.

But unfortunately our accident reports still show thousands of injuries to operators' hands and arms, due to faulty design in fixtures, tools, faulty methods of piling and handling stock, etc. The majority of these injuries are scratches, small cuts and abrasions. We have instructed the operators, time and again, to report to the First Aid Department to have these small injuries dressed; but we all know that these instructions are not followed, and the total time and money that are lost, due to these small injuries becoming infected, is tremendous. These conditions will continue if we do not put forth as much effort in specifying the safeguards for equipment and other sources that are causing these small injuries as we did in specifying the safeguards for equipment that was causing the major accidents.

A point that is often overlooked by machine designers and should be examined closely by the purchaser is the accessibility of the cutting tools. The machine should be designed so that all tools can be readily

changed when they become dull. If it is difficult to change tools you are building a hazard into a machine, because the operator will, sooner or later, injure his hands in changing tools and he is also likely to leave the tools in too long.

There are always some parts on a machine that are subject to wear or adjustment. The machine should be so designed that the parts that have to be replaced or adjusted are readily accessible to the repairmen. Here again, if it is difficult to repair or adjust a machine, necessary repairs are delayed, adjustments are made haphazard, and accidents will result. We have all seen an operator prepare to place his work in a chuck and then the chuck starts to revolve. The reason for this was because the adjusting screws or collars on the clutch were hard to get at and a poor or hurried adjustment was made.

All outside corners of machines and fixtures should have a liberal radius to remove sharp corners that have been responsible for accidents in the past. The machine designers lately have gone further than this on some machines. They have closed up the entire column to give the machine a streamlined appearance. In order to repair or adjust the mechanism inside the column, openings have been cut in the column and these openings have neat fitting covers that are held in place by a row of bolts around the cover to make an oil tight joint.

Some of these covers are quite heavy and they should be fitted with a hinge so that

1. His intellectual habits are slightly above the average, but not beyond the grasp of most of his workmen if they try to attain higher standards.

2. His physical habits are better than the average of the group he supervises.

3. His moral habits are above average but he is not a moral prude and does not try to reform or condemn his workers.

4. His emotional habits are such that he keeps "an even keel" but can show righteous indignation or shed a tear of human sympathy when everybody knows the situation demands it.

5. His dress and appearance is neat but not out of keeping with his job. (In some mills a foreman must wear a suit of clothes rather than overalls.)

6. He speaks *with* his men rather than *to* or *at* them in a language marked by correct diction, enunciation, and pronunciation. (He may swear at them if he smiles when he does so.)

7. He is a good judge of proper performance and knows how to direct it, but he loses respect if he insists on showing that

he can do every job better than his best men.

8. He exhibits intent to be fair in every decision. (He will be forgiven if he fails to exhibit fairness only if it does not happen too often and there is never any evidence of intent to be unfair.)

The range of each of these qualities is determined by the way the group thinks. This may seem too low for some of us. One supervisor said, "If I must have my personality attributed to me by that bunch, then I don't want a personality." Maybe that is why his 86 men disliked him and why he had a very bad record of efficiency and safety of production.

The fact is that unless you are willing to have your personality attributed to you by the group you lead, you have no right to be called the leader. Not only do you have no right, but you actually will not be the leader, even though you may be designated as such. If and when you are personally accepted by the group to whom you must sell your ideas, you will sell them if they promote efficiency on the part of the individuals.

ADJOURNMENT

Cement and Quarry Section

Officers 1939-1940

General Chairman—P. N. BUSHNELL, Missouri Portland Cement Co., St. Louis, Mo.
Vice-Chairman—R. A. DITTMAR, Universal Atlas Cement Co., Hudson, N. Y.
Vice-Chairman—*O. M. GRAVES, The General Crushed Stone Co., Easton, Pa.
Secretary—A. J. R. CURTIS, Portland Cement Assn., Chicago, Ill.
News Letter Editor—JACK DEMPSTER, Canada Cement Co., Ltd., Montreal, P. Q., Canada.
Engineering Committee Chairman—*J. B. ZOOK, Great Lakes Portland Cement Corp., Buffalo, N. Y.
Membership Committee Chairman—*HENRY A. RENINGER, Lehigh Portland Cement Co., Allentown, Pa.
Program Committee Chairman—H. F. YOTTER, The General Crushed Stone Co., Easton, Pa.
Publicity Committee Chairman—DAVID ADAM, Lawrence Portland Cement Co., Northampton, Pa.
Statistics Committee Chairman—W. W. ADAMS, U. S. Bureau of Mines, Washington, D. C.
Members at Large—
 TH. AVNSOF, Lone Star Cement Corp., New York, N. Y.
 *W. H. BAKER, J. E. Baker Co., York, Pa.
 E. D. BARRY, Universal Atlas Cement Co., New York, N. Y.
 J. R. BOYD, National Crushed Stone Assn., Inc., Washington, D. C.
 *R. B. FORTUIN, Pennsylvania-Dixie Cement Corp., Nazareth, Pa.
 *ALEXANDER FOSTER, JR., Warner Co., Philadelphia, Pa.
 *F. B. HUNT, Dewey Portland Cement Co., Davenport, Iowa.
 S. W. STAUFFER, National Lime Assn., Washington, D. C.
 *F. E. TOWN, Medusa Portland Cement Co., Manitowoc, Wis.
 *A. L. WORTHEN, The New Haven Trap Rock Co., New Haven, Conn.

Officers 1940-1941

General Chairman—R. A. DITTMAR, Universal Atlas Cement Co., Hudson, N. Y.
Vice-Chairman—O. M. GRAVES, The General Crushed Stone Co., Easton, Pa.
Vice-Chairman—W. M. POWELL, Medusa Portland Cement Co., Cleveland, Ohio.
Secretary—A. J. R. CURTIS, Portland Cement Assn., Chicago, Ill.
News Letter Editor—JACK DEMPSTER, Canada Cement Co., Ltd., Montreal, P. Q., Canada.
Engineering Committee Chairman—TH. AVNSOF, Lone Star Cement Corp., New York, N. Y.
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Publicity Committee Chairman—DAVID ADAM, Lawrence Portland Cement Co., Northampton, Pa.
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Members at Large—
 *W. H. BAKER, J. E. Baker Co., York, Pa.
 E. D. BARRY, Universal Atlas Cement Co., New York, N. Y.
 *Past General Chairman

- J. R. BOYD, National Crushed Stone Assn., Inc., Washington, D. C.
 *P. N. BUSHNELL, Missouri Portland Cement Co., St. Louis, Mo.
 *R. B. FORTUIN, Pennsylvania-Dixie Cement Corp., Nazareth, Pa.
 *F. B. HUNT, Dewey Portland Cement Co., Davenport, Iowa.
 S. W. STAUFFER, National Lime Assn., Washington, D. C.
 L. P. WARNER, JR., Warner Co., Philadelphia, Pa.
 *A. L. WORTHEN, The New Haven Trap Rock Co., New Haven, Conn.
 *J. B. ZOOK, Great Lakes Portland Cement Corp., Buffalo, N. Y.

*Past General Chairman

WEDNESDAY AFTERNOON SESSION

October 9, 1940

The opening session was called to order by General Chairman P. N. Bushnell, Manager, Safety and Personnel Department, Missouri Portland Cement Company, St. Louis, who presided. Chairman Bushnell welcomed the delegates, and made a brief report of activities of the Section during the past year. He commented upon many of the hard-working committees, and urged an

increase of teamwork for the heavy times ahead, in which cement companies will have large opportunities for cooperation for safety and national defense.

The list of officers for the coming year, as recommended by the Nominating Committee, was presented and formally endorsed by the delegates. Chairman Bushnell then introduced the first speaker.

Analysis of Cement and Quarry Industry Accident Experience

By I. F. LeGORE

Safety Engineer, Portland Cement Association, Chicago

Uppermost in the mind of every one of us are two vital safety problems: (1) The emergency problem of national defense, and (2) The perennial problem of industrial accident prevention.

In a time of stress it is essential that things go smoothly at top speed. In such a time, delay is dangerous—accidents that cause loss of time, damage to equipment or spoilage of materials might be called unintentional sabotage. The war on occupational injuries which we have waged in the past has been good training for the streamlined war we are going to have to wage to conserve men, materials and time in the year ahead. The tax program necessary to pay the cost of the national defense program will not take into account waste that adds to the cost of doing business.

We all know that effort and funds expended for accidents—for medical attention, for compensation to injured employees, for

machinery repair and materials spoilage—are time and funds thrown out the window. Accidents are pure waste; there is no return on expenditures required to repair damage that could have been and should have been anticipated.

Accident prevention means conservation of vital resources. Measures taken for the prevention of accidents, whether for guards, personal protective equipment such as goggles, hard hats and safety shoes, for improved machinery and equipment of safer design, and for better processes that enable work to be done with greater ease and dispatch, represent investment in material and personnel resources on which there is an important return. Not the least important dividends are returnable in the improved morale that is bound to result from the intelligent, competently administered safety program. No one in business, in national defense activities, or any other endeavor

can expect to get maximum results unless the conditions and the attitudes that make for maximum performance are provided.

Effect on Safety Work

Industry faces severe tests in the new conditions bound to arise as the result of today's great stresses and responsibilities. Equipment is being returned to service in a hurry that has not seen service in years. Augmented working forces are taxing working facilities and sanitary facilities.

Chief among the problems facing industrial safety forces is that of labor turnover. High levels of production will bring back old employees whose skill has been dulled by periods of idleness or employment on other kinds of work, and new and unskilled workers who have little, if any, knowledge of the hazards of their new jobs. Conscription may magnify this problem even though the government is expected to carry on its plans for military training activities with the least possible interruption to industries engaged in defense production.

The problem of education and training to increase the average skill and knowledge of personnel, with regard for the needs of the plant, is highly important. Education and training provide an opportunity for self-development by the employee which is a requisite for both real interest in his job and competent handling of the work he has to do, and does much to develop and maintain morale.

Morale, which I interpret as proper attitude not only towards the job to be done but also towards the whole setting in which the task is placed, is a condition of complete cooperation and is as important to the successful safety program as is adequate skill. Skills, motives and attitudes are the forces that make for success in any undertaking.

Modern warfare makes new demands upon the human mind and character. Already, the distractions caused by news from war-torn countries where some employees have relatives and friends, by prospects of conscription for military training, and by the general hustle and uncertainty have contributed to a rising accident trend in the country generally and are conspiring to reverse the favorable trend the portland cement industry has been able to report for several years. During the first seven months of 1940, all accidental deaths in the United States had increased 7 per cent over the

same period last year. Home deaths had increased 8 per cent, traffic deaths had increased 5 per cent, and occupational deaths had advanced a whopping 14 per cent.

In this emergency, industry must take advantage of the latest developments in personnel methods produced by extensive investigation and research. Application by industrial plants may include the making of job analyses and job classifications, the development of job specifications and rating scales and tests for selection. It is equally desirable that analysis of relations between functions, physical factors and human faculties be made by small plants as well as large.

Cement and Quarry Industry

In World War I the portland cement industry was considered non-essential. Fuel was rationed and the cement business marked time while other industries were operating full blast to supply war materials.

In the present program, however, our industry can perform an essential service in our country's defense.

We have at our command the latest, most powerful weapons for the war on accidents—new developments, new findings, new experiences, new tactics. The swing has been to selectivity and specialization: the rifle method rather than the shotgun.

The aim of the selective program is to narrow the problems of hazards, both environmental and human, and to strike hard at the important ones first. For three years the Accident Prevention Bureau of the Portland Cement Association has hammered relentlessly at the nine fundamental causes of accidents and the four causes of severest injuries. They have been spotlighted repeatedly in every publication sponsored by the Bureau, in the revitalized June No-Accident Campaign, in conferences on safety for supervisors, in regional safety conferences of top plant leaders throughout the country.

That this program has been effective is evidenced by the fact that injury frequency and severity rates were reduced almost one-half in the three-year period since 1936. Decline in those rates for the third successive year established 1939 as the safest in the 27-year history of accident prevention in our industry, with 4¼ men injured per million man-hours worked and a severity of about 2 days lost per thousand hours

ent pointed out that comprehensive job analyses have often been made as a method of establishing equitable wage rates; but an even more important development of these studies is the study of job hazards. Job analysis had been found by many to be valuable in determining whether new methods or equipment would make jobs safer. Experienced employees should be freely consulted in preparing the job descriptions on which studies are based.

A. S. HETHERINGTON spoke highly of the PCA Foremen Conference training course in instructing foremen to be competent teachers and stated that it has been demonstrated that foremen who are experts

in the work performed in their departments may not have adequate teaching ability. It was felt that current emphasis on the responsibility of foremen seeks to develop greater competence in discharging duties and influencing employees rather than to overload supervisors.

Opinion was divided as to whether foremen's meetings should be held on company time. Those who hold them on company time reported no difficulties arising from this practice. Those companies holding safety meetings outside of working hours usually provide dinners and sponsor a brief social program in the course of the evening.

ADJOURNMENT

Chemical Section

Officers 1939-1940

- General Chairman*—RALPH O. KEEFER, Aluminum Co. of America, Pittsburgh, Pa.
Vice-Chairman in Charge of Program—STANLEY WARZALA, The Calco Chemical Co., Inc., Bound Brook, N. J.
Secretary—F. W. DENNIS, Hooker Electrochemical Co., Niagara Falls, N. Y.
News Letter Committee—S. W. GURNEY (*Chairman*), Liberty Mutual Insurance Co., Boston, Mass.
 *A. L. ARMSTRONG, Rochester, N. Y.
 R. S. MACKIE, General Electric Co., Nela Park, Cleveland, Ohio.
 P. V. TILDEN, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Engineering Committee—D. S. McEACHERN (*Chairman*), American Cyanamid Co., New York, N. Y.
 F. W. JURICK, The Westvaco Chlorine Products Corp., Carteret, N. J.
 *S. E. WHITING, Liberty Mutual Insurance Co., Boston, Mass.
Data Sheet Committee—PLUMER WHEELER (*Chairman*), American Cyanamid Co., Linden, N. J.
 S. M. MACCUTCHEON, The Dow Chemical Co., Midland, Mich.
Health Committee—DR. LEONARD GREENBURG (*Chairman*), New York State Department of Labor, New York, N. Y.
 *J. S. SHAW, Hercules Powder Co., Wilmington, Del.
Membership Committee—C. E. SEVRENS (*Chairman*), Monsanto Chemical Co., Merrimac Div., Everett, Mass.
 W. L. HAMMERSLEY, Electric Storage Battery Co., Philadelphia, Pa.
Poster Committee—H. R. BIXLER (*Chairman*), Union Carbide & Carbon Corp., New York, N. Y.
 JOHN CLEMENTS, Michigan Alkali Co., Wyandotte, Mich.
 *RALPH L. ROGERS, JR., Tennessee Eastman Corp., Kingsport, Tenn.
Publicity Committee—S. D. KIRKPATRICK (*Chairman*), Chemical & Metallurgical Engineering, New York, N. Y.
 *A. L. WATSON, Koppers Co., Pittsburgh, Pa.
 CLARENCE WIGLE, Niagara Alkali Co., Niagara Falls, N. Y.
Safety Instruction Card Committee—E. F. KING (*Chairman*), Lever Brothers Co., Cambridge, Mass.
 *JOHN ROACH, Deputy Commissioner of Labor, Jersey City, N. J.
 K. E. ROOF, Willard Storage Battery Co., Cleveland, Ohio.
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*Past General Chairman

TUESDAY LUNCHEON SESSION

(October 8, 1940)

The opening session was a special luncheon meeting, attended by a large number of delegates. General Chairman Ralph O. Keefer, Purchasing Agent, Aluminum Company of America, Pittsburgh, Pa., presided.

Following the luncheon, the Chairman welcomed the delegates and guests, spoke briefly of the Section's activities during the past year, and then introduced the speaker of the occasion, Mr. O. S. True, whose address is given below.

The Use of Rubber and Rubber Compounds in the Chemical Industry

By O. S. TRUE

United States Rubber Company, New York, N. Y.

Strictly speaking, rubber as such would be of little value to the chemical industry. It owes its valuable properties to an ability

to combine chemically with certain substances such as sulphur, and to its ability to incorporate with and to hold in uniform

dispersion certain reinforcing materials such as carbon black. Also the quality and durability of modern compounds has been much improved by the addition of small quantities of accelerators and anti-oxidants, for the most part complex organic materials which improve the uniformity of the cure and increase the resistance to natural aging.

Rubber can be compounded so as to provide substantial resistance to corrosion and abrasion, as well as high dielectric, low co-efficient of heat transfer, and marked ability to absorb vibration and shock. These properties make rubber of value to the chemical industry.

With regard to corrosion, an ever-present problem in the chemical industry, rubber can be compounded to satisfactorily resist the following:

1. Most inorganic acids—including hydrochloric, phosphoric, dilute sulphuric, etc.
2. Most organic acids—such as acetic, formic, tartaric, etc.
3. Inorganic bases—caustic soda, etc.
4. Inorganic salts—chlorides, sulfates, etc.
5. Organic salts—acetates, tartrates, etc.
6. Bleach solutions—hypochlorites, chlorine solutions.

No one compound is satisfactory for use in connection with all of the above classifications but a suitable compound can be obtained for each individual requirement.

Rubber is not suitable for use with the following:

1. Strong oxidizing agents—such as nitric and chromic acids.
2. Aromatic hydrocarbons—such as benzol and toluol.
3. Aliphatic hydrocarbons—petroleum and its derivatives.

Rubber has one further limitation which should be borne in mind; namely, temperature. While compounders have improved the temperature resistance of rubber, 180 to 200 degrees F. must still be considered the practical maximum for industrial rubber goods, if long life is to be obtained.

For present purposes, some generalization may be made. There is the type abrasion caused by a material sliding over a surface, a shearing action, and there is the type caused by impinging of a material against a surface, abrasion due to impact. Between

the two extreme types is an infinite number of combinations. Different rubber compounds are necessary for different types of abrasion, but unless the impact is so severe as to cut the rubber to pieces, the proper compound has a very high degree of resistance to abrasion. Without qualitative tests it is not possible to say just how much more resistant rubber is than some other material, but such tests can be made if necessary. When corrosion and abrasion are both present, rubber is an ideal material although if the corrosive action is so severe as to make necessary a compound designed primarily to resist corrosion, it might be necessary to sacrifice some abrasion resistance.

With regard to dielectric for potentials up to 10,000 volts, rubber is generally considered the best available commercial insulation. Furthermore, rubber can be compounded to provide low water absorption, thus maintaining its high insulating factor, a characteristic not enjoyed by most other insulating materials. Rubber insulation finds its most common use with electric wires and cables, although it has also wide application in connection with electro chemical processes where resistance to corrosion and to stray current losses are both important.

The ability of rubber to absorb vibration and shock is due to a high degree of resilience. If displaced under load it immediately returns to its original position when the load is removed. The movement is accomplished with a minimum of internal friction. This characteristic enables engineers to design rubber springs and vibration dampeners, a recent application of rubber that is proving very beneficial in many of the process industries.

Rubber may be considered a good thermal insulator with coefficient of heat transfer corresponding approximately to that of asbestos. This permits transfer of solutions through rubber lined pipe with small loss of heat content, and evaporation in rubber lined vacuum crystallizers without excessive radiation. On the other hand, low heat transfer precludes the possibility of temperature control by indirect heating in rubber lined jacketed kettles or similar equipment, it being necessary to maintain temperature by heating coils or direct injection of steam.

Rubber compounds vary in tensile strength from 2,000 to 10,000 lbs. per sq. inch, in elongation or stretch from 800 per cent to

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*Past General Chairman

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Engineering Committee Chairman—C. H. BLACK, Stone & Webster Engineering Corp., Boston, Mass.

*Past General Chairman

TUESDAY AFTERNOON SESSION

October 8, 1940

The opening session was called to order by General Chairman R. J. Reigeluth, Vice President, C. W. Blakeslee & Sons, Inc., New Haven, Conn., who presided. Chairman Reigeluth reviewed in some detail activities

of the Section during the past year, and mentioned special work of many Sectional Committees. He spoke encouragingly of accident prevention plans for the future. He then introduced the first speaker.

Organizing a Steel Erection Job for Safety

By W. A. HAZARD

Engineer of Erection, Bethlehem Steel Co., Bethlehem, Pa.

We must concede that safety in any construction operation is very largely a matter of judgment on the part of the superintendent or foreman in charge. No matter how many rules are promulgated, or how carefully the instructions are given, unless the superintendent or foreman is safety conscious, it cannot be expected that the men working under his direction will give much serious thought to safety for themselves, or for others associated with them.

What plan or method then is to be pursued to instill safety mindedness in our employees?

In organizing a job for safety, one of the first things necessary is to provide a set of rules, though I prefer the word "Code," by which certain standards are established, which are to be followed throughout the operation.

Most of us are familiar with the A. G. C. Code, and there are others similar to it, all of them excellent for the purpose intended, but they were not prepared with the primary idea of having them placed in the hands of the individual workman.

Realizing that finally it is the workman who can to a very large degree control

safety conditions on the job, we have developed and printed a Safety Code of convenient size to fit the pocket, and intended for the individual use of the men. As soon as a man is signed up on a job, he is given this booklet and asked (mind you not *ordered*) to read it over at his leisure. The first printing of this Code was made in March, 1938, and so far, nearly 5,000 copies have been put into the hands of our employees.

It has long been an established rule with the Bethlehem Steel Company that before a man is put to work he must undergo a physical examination, to determine his fitness for the particular job to which he is to be assigned. A few years ago our company decided that this procedure should be extended to include the men in the field. This action, however, presented a problem that has been difficult of solution, especially on small jobs located in comparatively isolated territory. Strenuous opposition has occasionally been encountered from the men themselves, and in some localities certain organizations have refused to allow their members to submit to these examinations. We have been insistent that this rule be observed, and with the able assistance of our medical department, it is now possible to have every

man examined by a competent doctor before he is allowed to go to work.

We are convinced that physical examinations are essential for the protection of the workman, as well as the company. It is unfair to a man with defective vision, poor hearing, or a heart condition, to send him aloft on an erection job, while the same man, once the condition is detected, may be able to render valuable service and be safely employed on ground work. The records of these physical examinations are considered confidential, and are known only to the medical department of our company.

The chief surgeon of the company selects a doctor in the vicinity of the operation, in advance of the starting of work, advises him of the standards which have been established for fitness of the employee, and supplies him with the necessary forms for reporting these examinations. This same doctor is also designated to render service in all accident cases on the job. This procedure relieves the superintendent of the responsibility of seeking the proper medical service, and also establishes a uniform standard for measuring the fitness of our employees.

The steel erector is faced with two problems when organizing his job. He must provide suitable protection for his own employees, and in addition he is compelled to protect the employees of other interests. The latter case often proves the more difficult of solution. The site of the job is frequently found with old lumber full of nails, surplus material and all sorts of litter scattered about; as a result of the operations of others, and there have been a number of instances where we have been obliged to assign men to clear up the site, as a protection to our own employees.

One of the first rules in the code provides that the men employed on our operations must wear hard hats. These hats are furnished by the company, and it is the duty of the foreman to see that every man has his hat before he is allowed to go to work. It required a long struggle to convince the men that this protection was being furnished for their own good; it was only after a few accidents had occurred, when men were struck on the head by falling material and avoided serious injury by wearing these hats, that this opposition began to disappear.

Now comes the second problem—protection for the "other fellow." The steel erector,

almost from the start of his job, is obliged to work over other men; I regret to say that we have yet to find many contractors in the building line who seem inclined to furnish similar protection to their employees. Is it because accidents caused by falling material as a result of the erector's operation are not their responsibility? I do not attempt to answer, but no matter how carefully we police our jobs to endeavor to prevent the possibility of such accidents, they do happen all too frequently; and many serious injuries result, most of which would not have occurred if the victims had been provided with proper head protection.

As soon as the job is organized, usually during the first week of operation, a job safety committee is formed. The foreman is always chairman, and the timekeeper the clerk or secretary. The committee members consist of the pushers and two or more of the workmen, the number being dependent upon the size of the operation and the total number of men on the job. On the smaller jobs, where only a few men are involved, the entire crew constitutes the committee.

Meetings of the committee are required to be held weekly, or bi-weekly in some instances, for the sole purpose of considering safety on the job. Accidents which have occurred since the last meeting of the committee, whether major or minor in character, are analyzed, and the opinions of the members as to the possibility of avoiding such occurrences in the future, are obtained. We firmly believe that free discussion of accidents on the job, while the incidents are fresh, helps materially to fix ideas of safe practice and safe working conditions in the minds of the men, and affords opportunity to point out what results from carelessness of the men themselves in the conduct of the operation.

The secretary keeps the minutes, which he later transcribes; and copies are sent to headquarters. These meetings are held at any convenient time of the day or week, it being left to the discretion of the foreman as to the time, and a record is kept in the general office of the number held each month on each job. During the first six months of this year 453 such meetings were held.

When this committee idea was inaugurated, it was thought that the foreman, as chairman, would be able to initiate and carry through the discussions, since it was sup-

serious accident. Now "Speed too fast for conditions" would certainly be used in formulating any definition of what speeding is.

I. GORDON (Bureau of Safety, Chicago): That is my question and I am complimented that you have answered it like I did, when it was asked me at a safety meeting. I said that I had just bought a new automobile and I would consider five miles an hour speeding. Of course, I got a big laugh out of 250 people. They said, "Wait until you get used to it and then seventy-five will be the speed perhaps."

I said, "Wait a minute. You did not wait until I had finished. Five miles an hour is speeding if you are going around a corner where there are children or pedestrians." In other words, the answer was "under the conditions."

At a safety meeting yesterday we heard a man say that he came to the safety meeting at seventy-five miles an hour. He was in a hurry to get here—coming to a safety meeting. He came up behind a truck. He did not know that there was another truck in front of this one, but suddenly the fellow in front took a notion that he wanted to talk to the fellow in the rear and they both slackened up until he had to cut away in order to avoid an accident. But he was coming to a safety meeting, traveling seventy-five miles an hour, too fast for any safety man.

CHAIRMAN HAVEN: That is absolutely right. I am going to take the liberty of repeating four rules of safe driving in our defensive driving program, which covers this very important question. We are trying to get across to our employees inside the plant, as well as to our salesmen drivers, the idea of defensive driving. (1) Maintain an area of safety in front, back and both sides of your car. (2) Drive at a speed consistent with road surface, visibility and traffic conditions. (3) Forget who has the legal right of way and do the common-sense thing of staying out of the other fellow's way. (4) Drive your car on the theory

that the other driver or pedestrian is deaf, dumb, blind, and knows little about the traffic laws.

Four simple fundamentals and yet they cover the whole gamut of safe driving.

Incidentally, I want to refer to an exhibit I have here, which we use in our plants for accident demonstration purposes. When a man comes in to tell what happened in connection with an accident, he takes these cut-outs with which you can make any type of street intersection, reverse curve, or what have you. It is made to scale, so that he can place the pieces in position to show locations of cars and other objects involved. Stopping distances are also shown on this chart. If your man says, "I was going down the street at so many miles per hour," here are the distances and you can very soon tell him that he was traveling too fast.

MR. BRODERICK: Along many highways you will see a "50 miles" sign here, then 35 miles, then 20 and then 40. Why should there not be a federal law governing all these things all over America, so that when a man goes from one state to another he does not have to pick up a pilot like a ship does when going into a new port? There ought to be a federal law, a general law, governing the entire motor traffic so that you could go from state to state and be perfectly safe provided you keep within that law.

CHAIRMAN HAVEN: I think that the National Safety Council for at least fifteen years has been working with various enforcing bodies to bring about uniform traffic laws and they are making wonderful strides. Now, that would be an ideal condition and probably it will come sometime, whether it will be a federal regulation or not, but just remember that after you do have the law you still have Mr. John Jones and Bill Smith and the rest of those fellows to educate, and the way to educate them is right in your own establishments where you are working with a large number of people.

ADJOURNMENT

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Chairman, Minimum Safety Standards Committee—E. P. HERGES, U. S. Employees' Compensation Commission, Washington, D. C.

MONDAY AFTERNOON SESSION

October 7, 1940

The opening session of the Marine Section was called to order by Major W. E. Lorence, Safety Officer, Corps of Engineers, United States War Department, Washington, D. C., who presided. Chairman Lorence

welcomed the delegates, briefly commented on the extensive and diverse program which had been prepared for the several meetings, and then introduced the first speaker, Major Elliott Vandevanter.

simply created another hazard, because there was a temptation for youngsters to jump on the moving vehicle. They have evolved a new type of step so that the moment the truck starts up, one revolution of the wheel, the step drops out of position and remains that way until the truck comes to a standstill again.

MR. LEE: I was in one of the large plants here in Chicago where they use quite a few trucks that run around through the departments. At intersections of the aisles they had large mirrors at such an angle that the fellow coming up one aisle could see the fellow coming from another direction.

MR. HANAU: I would like to ask one of the leather men or tanning men whether they have ever seen a guard on a staking machine or roll jack as specified in, I think it is, A.S.A. standards, which says that a fence should be provided around the thing so that a man can't get his hand under that. I have seen pictures of them, but I don't recall seeing one that worked.

CHAIRMAN SCHAFFNER: Mr. Clover, can you answer that?

MR. CLOVER: As to the Slocum staker you have in mind, where a man puts the hide in on the side and has to work it through—

MR. HANAU: Either the side or front. There is an arm that comes down.

MR. CLOVER: I don't know of any guard that is put at the point of operation. They do bring the guard up to a certain point on the arm, and they cover the fly-wheel below. As to actually guarding the point of operation on this staker, I don't believe it has been done. With the exception of sole leather, the glazing jacks have been guarded. They are guarded at the point of operation by having a basket type guard around them, with provision made at the front, point of operation, to slide the skin from the left to the right or the right to the left, whichever way it is. If their hand or the skin of the hide is jerked in, the hand is knocked loose before it goes into the roller. There are some very good guards that you can make up to suit your condition.

MR. HANAU: Can you tell me where I can see one of those in operation in this area?

MR. CLOVER: I can send you some pictures of them.

MR. HANAU: I will be glad to have them.

MR. TEFFT: Mr. Lee referred to visual education. I would like to tie that up with a discussion of aprons, if I may. Cuts from beef boning operations are rare, but when they happen they are horrifying. I know of one man who bled to death in ten minutes. He cut a big artery.

Do you think it would be of any value if pictures were taken of beef boning operations to show the men how many times a day that knife almost cuts them but doesn't, and use those in a slow motion picture? Then they might take to some of the aprons a little bit more readily than they do at the present time.

MR. LEE: I think so. My suggestion would be that you have the still picture or the stereopticon slide first, because it seems to me that is the best medium for detail information and round table discussion. Then, after that, show the movie. The movie, in the first place, would be too fast. If you have it first in the still picture and go through the fine points and what he did and what he should have done, and so forth, then show him actually doing it in the picture, I think that would be ideal.

MR. TEFFT: I had in mind that you would have to take a motion picture because those fellows work so fast you can't see where the knife is. If you took the motion picture, then you could pick out the proper stills and make the stills from your motion pictures.

MR. LEE: Yes.

MR. HANAU: I saw a demonstration of that yesterday, in the Metals Section. Somebody took some shots of a punch press operator. He caught a particular operation he was interested in and then he made a loop film; in other words, he cemented the two ends and kept running in through the machine. It was very effective.

Metals Section

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MONDAY AFTERNOON SESSION

October 7, 1940

The session was called to order by General Chairman H. J. Griffith, Manager of Safety and Welfare, Jones and Laughlin Steel Corporation, Pittsburgh, Pa., who presided. Chairman Griffith, in commenting on "Activities of the Metals Section" during

the past year, took the opportunity to praise the chairmen of many standing committees.

The Report of the Nominating Committee was called for, and officers for the Section were elected, as presented elsewhere in this record.

"True or False?"

The session had been planned as a Panel Discussion of a number of safety problems, called a "Quiz." These problems had been mimeographed and distributed to the delegates, who found below each problem the words "True or false?" The list complete is as follows:

1. When new machinery is installed, the Safety Engineer should have final say as to whether or not the machinery is safely guarded before it is put into production.

True _____ False _____

2. When an employee works on an operation which necessitates the wearing of

goggles, he should be allowed to pick the type of goggle which he is to use.

True _____ False _____

3. When a new employee is put to work, the foreman should give him instructions in accident prevention and not merely show him the operation and tell him to be careful.

True _____ False _____

4. Education in off-the-job accident prevention is an essential part of a plant safety program.

True _____ False _____

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 *Past General Chairman

MONDAY AFTERNOON SESSION

October 7, 1940

The session was called to order by General Chairman Angus D. Campbell, Safety Engineer, McIntyre Porcupine Mines, Ltd., Schumacher, Ontario, Canada, who presided.

In his opening remarks the Chairman sketched activities of the Section and Standing Committees during the past year, and then introduced the first speaker.

A Course of Training Foremen for Safety Work

By F. E. BEDALE

Assistant to General Manager, in Charge of Safety, Consolidated Coal Co. Inc., Fairmont, W. Va.

Before one can even start the education of the foreman a great deal of ground work must be done—a price must be paid for safety.

A safety program must be decided upon and unless the executive officials realize that such a program is merely a sound and profitable operating program and are willing to cooperate and stand behind such a program, the desired results cannot be obtained.

A department of safety should be organized with a director or chief reporting directly to someone of the higher executive officials. This department should have sufficient mine inspectors, ventilation inspectors and other field men to properly cover the various operations of the company. There must be an office force sufficient to study and properly assemble the information turned in by the field force.

The first work of the safety department is to study the past record of the company. This study should cover the various accident causes. The official foreman organization should be studied; many of these men will, or should be excellent material for the program that is to be carried out. The study of the foremen on the job is a difficult one and must not be hurried, it may take a year or more. You must have a report of the conditions found under each foreman, meet them personally and find out whether they are popular with their men; whether they are able to have orders carried out, or whether they are considered "easy marks." The health, habits and thousand and one little things that go to make up personality should be ascertained for each foreman.

Arrangements must be made to have a report covering each and every accident that occurs and a method of classifying these injuries. This process, carefully carried out will automatically determine where and how injuries are occurring. A method of permanently classifying your foremen should be made. This is done by keeping a record of each individual foreman, charging to his ac-

count each personal injury occurring under his jurisdiction. The causes of these accidents will probably disclose just where each foreman needs training and education. This preliminary work will determine, to a large extent, just how the foremen on the job will fit into the new company policy.

Whether new foremen are employed or whether the old ones are retained, the maximum benefits cannot be realized unless careful consideration is given to fundamental qualifications. Intelligence and a magnetic personality, in addition to experience, must be weighed carefully. A well rounded high school education is desirable, its equivalent should be required. Each foreman underground should hold a first grade mine foreman's certificate, a first aid certificate and a mine rescue certificate. Ambition and a sense of loyalty to the company and its operating policy are essential qualities if the educational effort is to bear favorable results.

As the work progresses the first step toward the education of the foremen is the preparation of a set of safety standards and operating rules. This involves an enormous amount of study and work. The safety standards and operating rules must cover all phases of operation underground and on the surface. They should be gone over by the entire executive staff, criticized, corrected and revised; then sent in preliminary form to the superintendents, foremen and others for criticism and suggestions, until finally you have what is really a text book for your operations.

By the time the safety standards and operating rules are prepared you will have completed your preliminary study of the foremen and laid the ground work of making them receptive to a safety education. You have impressed upon them that safety is pure operation with care and common sense, that safety and good mining are synonymous and that safety and mining efficiency are usually found together.

The next fundamental step is to place a complete set of the operating rules in the

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36. Johnson, John A., Agnew, Wing G., and Mosier, McHenry. Stemming in Metal Mines. Progress Report 1: Bureau of Mines Rept. of Investigations 3509, 1940, 27 pp.

ADJOURNMENT

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ROBERT M. ALTMAN, Marathon Paper Mills Co., Rothschild, Wis.
KENNETH L. FAIST, The Champion Paper & Fibre Co., Hamilton, Ohio.

WALTER A. GLEASON, Hammermill Paper Co., Erie, Pa.
 E. E. GRANT, The Crystal Tissue Co., Middletown, Ohio.
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 C. O. HOLMER, Minnesota & Ontario Paper Co., Minneapolis, Minn.
 D. A. McALARY, Fraser Companies, Ltd., Edmundston, N. B., Canada.
 E. A. PAGE, Kimberly-Clark Corp., Neenah, Wis.
 G. R. VAUGHAN-EVANS, Anglo-Newfoundland Development Co., Ltd., Grand Falls, Newfoundland.
Health Committee Chairman—DR. LOUIS H. FRECHTLING, Champion Paper & Fibre Co., Hamilton, Ohio.
Statistics Committee Chairman—FRED W. BRAUN, Employers Mutuals, Wausau, Wis.
Publicity Committee—WALTER E. STRONG (Chairman), Menasha Products Div., Marathon Paper Mills Co., Menasha, Wis.
 R. P. ALMOUR, Fibreboard Products, Inc., Los Angeles, Calif.
 J. C. FITZGERALD, Bowater's Newfoundland Pulp & Paper, Ltd., Corner Brook, Newfoundland.
 O. R. HARTWIG, Crown Zellerbach Corp., Portland, Ore.
Safety Instruction Card Committee—R. W. CROUCHER (Chairman), Minnesota & Ontario Paper Co., International Falls, Minn.
 ERNEST AUGUSTUS, The Mead Corp., Chillicothe, Ohio.
 G. J. BIENVENU, Gaylord Container Corp., Bogalusa, La.
 H. P. HEURNER, The Flintkote Co., New York, N. Y.
 JOHN M. LAVIN, St. Croix Paper Co., Woodland, Maine.
 C. J. MUNK, Racquette River Paper Co., Potsdam, N. Y.
 ARTHUR E. WINSLOW, Hollingsworth & Whitney Co., Waterville, Maine.

Visual Education Committee—J. R. SIMPSON (Chairman), The Brown Paper Mill Co., Inc., Monroe, La.
 A. S. COOK, Quebec Pulp & Paper Safety Assn., Quebec, Canada.
 D. S. GARRER, Hummel & Downing Co., Milwaukee, Wis.
 J. W. KUEBLER, Dixie-Vortex Co., Easton, Pa.
 J. R. LATTER, Anglo-Canadian Pulp & Paper Mills, Ltd., Quebec, Canada.
 DON E. McDOWELL, Kalamazoo Vegetable Parchment Co., Parchment, Kalamazoo County, Mich.
 B. L. WOOD, American Coating Mills, Inc., Elkhart, Ind.
Past General Chairmen—
 GEORGE J. ADAMS, International Paper Co., Glens Falls, N. Y.
 ROBERT M. ALTMAN, Marathon Paper Mills Co., Rothschild, Wis.
 KENNETH L. FAIST, The Champion Paper & Fibre Co., Hamilton, Ohio.
 WALTER A. GLEASON, Hammermill Paper Co., Erie, Pa.
 E. E. GRANT, The Crystal Tissue Co., Middletown, Ohio.
 M. G. HOYMAN, Kimberly-Clark Corp., Neenah, Wis.
 G. W. PHILLIPS, The Champion Paper & Fibre Co., Canton, N. C.
 J. J. PLZAK, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.
 SAMUEL PRUYN, Finch, Pruyne & Co., Inc., Glens Falls, N. Y.
 S. F. SHATTUCK, Kimberly-Clark Corp., Neenah, Wis.
 GEORGE E. WILLIAMSON, Strathmore Paper Co., West Springfield, Mass.

MONDAY AFTERNOON SESSION

October 7, 1940

The opening session of the Paper and Pulp Section convened with General Chairman D. B. Chant, Ontario Pulp & Paper Makers' Safety Association, Toronto, Ontario, Canada, presiding.

CHAIRMAN CHANT: We are very glad to see so many here at this first session. We have an old custom which we have followed for a number of years: that is, for each person attending this first session of our Congress to rise in turn and introduce himself, naming his company affiliation. Let us again follow the custom this year.

(The members arose individually and introduced themselves.)

CHAIRMAN CHANT: As your General Chairman, I look back over the past year with mingled feelings of satisfaction and regret: satisfaction because of progress made, and regret over lost opportunities and failure to accomplish some of the things we had hoped we might achieve.

The year has not been a normal one, either in our industry or the economic life of North America. There is no need for me

to detail to you the disturbing elements which have made themselves felt with growing force as the flames of war rose higher and higher with each month since the Atlantic City Congress. No doubt the months ahead will also bring many surprises and many new and difficult problems to each of us.

To me, however, there is something particularly encouraging in the way the work of the National Safety Council has been steadily pushed forward during these evil days. With so much of the world's area seemingly abandoned to the forces of destruction and violence, the knowledge that here in America thousands of men and women are voluntarily giving unselfishly of their time and efforts for the betterment of human welfare, safety and health, must constitute a sure guarantee that those great democratic ideals of liberty and justice, to which your nation and mine are dedicated, shall forever prevail, and, come what may, that "government of the people, by the people, and for the people shall not perish from the earth."

I am no artist but I can copy pretty well. Some safety posters issued by the Council I have reproduced and then had mimeographed in two colors, naturally with French wording.

CHAIRMAN CHANT: I am familiar with some of the difficulties that Mr. Cantin and his associates in the province of Quebec have had in obtaining suitable poster material. I am much interested in what he has accomplished. I know that pressure has been put on our section poster committee or Visual Education Committee for several years back so that we might, through them, reach the Council poster department with the view of getting posters put out by the Council worded in French. But we run up against the fact that the demand for such material is limited and the Council can't afford to make up such material in small quantities.

The answer seems to lie in the fact, as shown by Mr. Cantin, that the company itself has to do much of this sort of thing. In time we may be able to do something about this through the Council. At least I hope so. The first requirement toward that end, of course, is to get more members—more Council members and more section members—from those localities where such

posters are required. If we can get to the point where we can say to the Council, "We need 1,500 or 2,000 of these French posters every month," then they may be able to supply them without too much expense, but when it is only a matter of supplying 25 or 50 such posters, then the Council naturally informs us that it cannot afford to do so.

Is there anything else, gentlemen? If not, may I again thank you all for coming here and express to you my appreciation for the very free and worthwhile discussions that we have had at these meetings? You have all taken a splendid part in them and I am sure we will go home with some new ideas to make use of in our own work, as well as with some very happy recollections of this congress.

MR. STRONG: Gentlemen: I think that this group should express to Doug Chant a vote of thanks for his continuous efforts in holding this group together and building a program and giving us the fine meetings which we have had. Suppose we give him a rising vote of thanks.

(The audience arose and enthusiastically applauded.)

CHAIRMAN CHANT: Thank you very much, gentlemen. It is undeserved but appreciated nonetheless.

ADJOURNMENT

Petroleum Section

Officers 1939-1940

- General Chairman*—C. J. NORMANN, Shell Oil Co., Inc., Sacramento, Calif.
Vice-Chairman for Production—H. T. MARKEE, Phillips Petroleum Co., Bartlesville, Okla.
Vice-Chairman for Pipelines—C. A. MILLER, The Texas Co., Houston, Texas.
Vice-Chairman for Manufacturing—J. HOWARD MYERS, The Atlantic Refining Co., Philadelphia, Pa.
Vice-Chairman for Marketing—F. R. MCLEAN, White Star Div., Socony-Vacuum Oil Co., Inc., Detroit, Mich.
News Letter Editor—H. B. WILLIAMS, Pan-American Refining Corp., Texas City, Texas.
Engineering Committee Chairman—J. P. SUTTON, Ohio Oil Co., Findlay, Ohio.
Health Committee Chairman—DR. J. W. LONG, Gulf Oil Corp., Port Arthur, Texas.
Industrial Data Sheet Committee Chairman—H. E. DISCHINGER, Shell Oil Co., Inc., St. Louis, Mo.
Program Committee Chairman—J. H. BROWN, Tide Water Associated Oil Co., New York, N. Y.
Publication Committee Chairman—J. C. YOUNG, Tide Water Associated Oil Co., Tulsa, Okla.
Statistics Committee Chairman—HADLEY H. MYERS, Sinclair Prairie Oil Co., Tulsa, Okla.
Visual Education Committee Chairman—T. S. MAFPITT, JR., Houston Oil Co. of Texas, Houston, Texas.
Atlantic Division Chairman—J. W. LORD, The Atlantic Refining Co., Philadelphia, Pa.
Great Lakes Division Chairman—FRANK HARRISON, Pure Oil Co., Chicago, Ill.
Gulf Division Chairman—W. I. KENT, Magnolia Petroleum Co., Dallas, Texas.
Mid-Continent Division Chairman—F. K. DALRYMPLE, Tide Water Associated Oil Co., Tulsa, Okla.
New England Division Chairman—JOHN W. WELCH, Cities Service Oil Co., East Braintree, Mass.
Pacific Coast Division Chairman—A. J. MARTINSON, California Petroleum Safety Board, Inc., Los Angeles, Calif.
Past General Chairmen—
 R. W. BLACK, Standard Oil Co. of N. J., Elizabeth, N. J.
 H. W. BOGGESE, Sinclair Prairie Oil Co., Tulsa, Okla.
 R. S. BONSIB, Standard Oil Co. of N. J., New York, N. Y.
 A. W. BREELAND, Lone Star Gas Co., Dallas, Texas.
 J. H. BROWN, Tide Water Associated Oil Co., New York, N. Y.
 R. E. DONOVAN, Standard Oil Co. of Calif., San Francisco, Calif.
 C. L. HIGHTOWER, United Gas Pipe Line Co., Shreveport, La.
 G. O. LOCKWOOD, Continental Casualty Co., Tulsa, Okla.
 GEO. F. PRUSSING, Union Oil Co. of Calif., Los Angeles, Calif.
 R. B. ROAPER, Humble Oil & Refining Co., Houston, Texas.
 E. J. SENNE, 61 Park Avenue, Baldwin, N. Y.
 C. W. SMITH, Standard Oil Co. (Ind.), Chicago, Ill.
 D. J. WALLACE, Sinclair Prairie Oil Co., Tulsa, Okla.
Secretary—H. N. BLAKESLEE, American Petroleum Institute, New York, N. Y.

Officers 1940-1941

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Vice-Chairman for Pipe Lines—J. L. MANES, Sun Oil Co., Dallas, Texas.

Vice-Chairman for Manufacturing—J. HOWARD MYERS, The Atlantic Refining Co., Philadelphia, Pa.

Vice-Chairman for Marketing—F. R. McLEAN, White Star-Ohio Div., Socony-Vacuum Oil Co., Inc., Detroit, Mich.

News Letter Editor—GEORGE A. LEXANDER, Socony-Vacuum Oil Co., Inc., Boston, Mass.

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Health Committee Chairman—DR. J. W. LONG, Gulf Oil Corp., Port Arthur, Texas.

Industrial Data Sheet Committee Chairman—J. L. RISINGER, Socony-Vacuum Oil Co., Inc., New York, N. Y.

Program Committee—J. L. MANES, Sun Oil Co., Dallas, Texas.

H. T. MARKEE, Phillips Petroleum Co., Bartlesville, Okla.

F. R. McLEAN, White Star-Ohio Div., Socony-Vacuum Oil Co., Inc., Detroit, Mich.

J. HOWARD MYERS, The Atlantic Refining Co., Philadelphia, Pa.

Publicity Committee Chairman—R. S. HUFFMAN, Oklahoma Natural Gas Co., Tulsa, Okla.

Visual Education Committee Chairman—T. S. MAFFITT, JR., Houston Oil Co. of Texas, Houston, Texas.

Atlantic Division Chairman—A. H. VINEYARD, Shell Oil Co., Inc., New York, N. Y.

Great Lakes Division Chairman—J. W. ATKINS, The Texas Co., Lockport, Ill.

Gulf Division Chairman—HARVEY B. WILLIAMS, Pan American Refining Corp., Texas City, Texas.

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Pacific Coast Division Chairman—BARTON CATER, Standard Oil Co. of Calif., Los Angeles, Calif.

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R. S. BONSBIE, Standard Oil Co. of N. J., New York, N. Y.

A. W. BREFELAND, Lone Star Gas Co., Dallas, Texas.

J. H. BROWN, Tide Water Associated Oil Co., New York, N. Y.

R. E. DONOVAN, Standard Oil Co. of Calif., San Francisco, Calif.

C. L. HIGHTOWER, United Gas Pipe Line Co., Shreveport, La.

G. O. LOCKWOOD, Continental Casualty Co., Tulsa, Okla.

C. J. NOBMAN, Shell Oil Co., Inc., Sacramento, Calif.

GEORGE F. PRUSSING, Union Oil Co. of Calif., Los Angeles, Calif.

R. B. ROOPER, Humble Oil & Refining Co., Houston, Texas.

E. J. SENNE, Baldwin, N. Y.

C. W. SMITH, Standard Oil Co. (Ind.), Chicago, Ill.

D. J. WALLACE, Sinclair Prairie Oil Co., Tulsa, Okla.

Secretary—H. N. BLAKESLEE, American Petroleum Institute, New York, N. Y.

MONDAY AFTERNOON SESSION

October 7, 1940

The opening session was called to order by Vice-Chairman Charles A. Miller, Assistant to the Manager of Personnel, The Texas Company, Houston, Texas, who presided. This session had been devoted largely to annual reports by Standing Committees of the Section, the following being scheduled:

Pipelines: Vice-Chairman Charles A. Miller.

Production: H. T. Markee, Supervisor of Safety, Phillips Petroleum Co., Bartlesville, Okla.

Manufacturing: J. Howard Myers, Supervisor of Safety and Fire Protection Division, The Atlantic Refining Co., Philadelphia.

Marketing: F. R. McLean, Safety and Insurance Departments, White Star-Ohio Division, Socony-Vacuum Oil Co., Detroit.

Cleaning Gasoline Storage Tanks Used for Leaded Gasoline

By OSCAR B. LEWIS

Manager Safety Department, Ethyl Gasoline Corporation, New York City

For a number of years the medical department of the Ethyl Gasoline Corporation has been studying the hazards connected with the cleaning of tanks that have contained leaded gasoline. With the cooperation of the petroleum industry data have been obtained which in our opinion show that a definite hazard exists.

Serious cases of lead poisoning—several fatal—have occurred from exposure in tanks that have contained leaded gasoline, but these have occurred only when such tanks were cleaned without following our recommended safeguards.

To aid the petroleum industry in establishing safe practices in cleaning gasoline tanks that have contained leaded gasoline, we are summarizing briefly the results of a recent analytical study of samples of sludge, scale and water bottoms for such tanks:

An appreciable number of samples of sludge had an inorganic lead content sufficiently high to be considered dangerous, but practically all such samples came from refinery tanks into which litharge had been introduced. No significant difference in organic lead content was found to exist between sludge of tanks used for mixing leaded gasoline and sludge of storage tanks. Both types of tanks may contain dangerous amounts of organic lead compounds.

Neither the organic nor the inorganic lead

content of the sludge was significantly affected by size of tank, frequency of cleaning, geographical location, length of service or by steaming. Any tank that has contained leaded fuel may offer serious danger of lead exposure. This danger is due to volatile organic lead compounds in the sludge, and to the presence of these compounds in the scale as well. There may be additional danger from inorganic lead compounds in the water bottoms and sludge, as the result of the use of lead compounds other than tetraethyl lead, in the treatment of gasoline.

It is apparent, therefore, that no tank used for leaded gasoline may be assumed to be free from a lead hazard. This applies with equal force in the case of refinery, terminal, bulk, trackside or any other tank which is entered for cleaning or repair.

One of the most discussed phases of tank cleaning is steaming, and the part it plays in the process of freeing tanks from gases which might cause fire or explosion, or asphyxiation. In the latest A.P.I. manual dated August, 1931, the following appears on this subject.

1. "After all lines are blanked, the bottom manheads are opened as the first step in ventilating the tank. If steam is used to heat the tank preparatory to ventilation, the top manheads are usually left closed and the steam is introduced through a swing line or other bottom connection.

and the Universal Safety Emblem, which were given to winners of first place in the contest; and of Certificates of Merit, each a handsome lettered scroll, which were given to winners of second and third places.

In the lists below, winners of first place are indicated by the numeral (1), and winners of second and third places by the numeral (2) and (3) respectively.

Manufacturing Department Group A

1. Standard Oil Company of Louisiana, Baton Rouge, La., 7,371,365 hours, 6 injuries.

2. Standard Oil Company, Indiana, Chicago, Ill., 12,445,593 hours, 23 injuries.

3. Humble Oil & Refining Company, Houston, Texas, 8,941,060 hours, 24 injuries.

Manufacturing Department Group B

1. The Ohio Oil Company, Findlay, Ohio, 1,339,707 hours, 3 injuries.

2. Pan American Petroleum Corp., New York, N. Y., 400,023 hours, 1 injury.

3. Indian Refining Company, Lawrenceville, Ill., 1,194,977 hours, 3 injuries.

Wholesale Marketing Department Group A

1. Continental Oil Company, Ponca City, Okla., 4,680,606 hours, 8 injuries.

2. General Petroleum Corporation of California, Los Angeles, Cal., 2,032,418 hours, 4 injuries.

3. Standard Oil Company, Indiana, Chicago, Ill., 29,647,376 hours, 88 injuries.

Wholesale Marketing Department Group B

1. Texas Pacific Coal and Oil Co., Fort Worth, Texas, 227,365 hours, no injuries.

1. Globe Oil & Refining Co., Wichita, Kan., 156,756 hours, no injuries.

3. Panhandle Refining Company, Wichita Falls, Texas, 757,464 hours, 2 injuries.

Natural Gasoline Department

1. Shell Oil Co., Inc., Mid-Continent Territory, St. Louis, Mo., 335,645 hours, no injuries.

1. General Petroleum Corporation of California, Los Angeles, Cal., 267,335 hours, no injuries.

1. Hope Construction and Refining Company, Pittsburgh, Pa., 226,417 hours, no injuries.

Oil & Gas Pipe Line Department Group A

1. Stanolind Pipe Line Company, Tulsa, Okla., 3,547,300 hours, 13 injuries.

2. Humble Pipe Line Company, Houston, Texas, 4,348,900 hours, 32 injuries.

3. Magnolia Pipe Line Company, Dallas, Texas, 2,731,114 hours, 23 injuries.

Retail Marketing Department

1. Humble Oil & Refining Company, Houston, Texas, 336,718 hours, no injuries.

Oil & Gas Pipe Line Department Group B

1. Kaw Pipe Line Company, Tulsa, Okla., 266,628 hours, no injuries.

1. Tide Water Pipe Line Co., Ltd., Bradford, Pa., 208,577 hours, no injuries.

1. Sinclair Wyoming Oil Co., Tulsa, Okla., 201,678 hours, no injuries.

1. Charleston Oil Company, Charleston, S. C., 108,120 hours, no injuries.

3. Union Oil Company of California, Los Angeles, Cal., 4,313,872 hours, 28 injuries.

Producing Department Group A

1. Continental Oil Company, Ponca City, Okla., 2,730,567 hours, 12 injuries.

2. Stanolind Oil and Gas Company, Tulsa, Okla., 3,777,851 hours, 23 injuries.

3. Gulf Oil Corp., Gulf Production Div., Houston, Texas, 3,736,734 hours, 25 injuries.

Producing Department Group B

1. The Atlantic Refining Company, Dallas, Texas, 1,140,704 hours, 4 injuries.

2. Hope Construction and Refining Co., Pittsburgh, Pa., 493,797 hours, 2 injuries.

3. Texas Pacific Coal and Oil Company, Fort Worth, Texas, 416,598 hours, 2 injuries.

Drilling Department

1. Standard Oil Company of Louisiana, Shreveport, La., 125,919 hours, 1 injury.

2. Cities Service Gas Company, Bartlesville, Okla., 120,692 hours, 2 injuries.

3. Gulf Oil Corporation, Gulf Production Div., Houston, Texas, 1,162,557 hours, 2 injuries.

Power Press Section

Officers 1939-1940

General Chairman—M. R. ZELDER, Edison General Electric Appliance Co., Inc., Chicago, Ill.

Vice-Chairman—G. H. BERRY, Western Electric Co., Chicago, Ill.

Secretary and News Letter Editor—O. C. BOILEAU, RCA Manufacturing Co., Inc., Camden, N. J.

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F. W. FISKE, The Brewer-Titchener Corp., Cortland, N. Y.

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C. J. KOLB, Colonial Radio Corp., Buffalo, N. Y.

Health Committee—DR. R. J. DEMOTTE (*Chairman*), Pullman-Standard Car Manufacturing Co., Pullman, Chicago, Ill.

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Industrial Data Sheet Committee—W. J. GRAVES (*Chairman*), Michigan Mutual Liability Co., Detroit, Mich.

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R. W. HOBSON, Gorham Manufacturing Co., Elmwood, Providence, R. I.

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H. A. McDONALD, Erie Forge Co., Erie, Pa.

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A. H. PFEIFFER, Harnischfeger Corp., Milwaukee, Wis.

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B. J. HINE, Scovill Manufacturing Co., Waterbury, Conn.

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H. C. HOWSAM, Hubbard Spool Co., Chicago, Ill.

P. G. HUNTER, Motor Wheel Corp., Lansing, Mich.

G. A. KUECHENMEISTER, Dominion Forge & Stamping Co., Walkerville, Ont., Canada.

T. O. MEISNER, American Can Co., Chicago, Ill.

*Past General Chairman

ADJOURNMENT

- *B. E. ROCKHOFF, Detroit Steel Products Co., Detroit, Mich.
 *S. H. SLAYMAKER, Fairbanks Morse & Co., Beloit, Wis.
 H. L. VITS, Aluminum Goods Manufacturing Co., Manitowoc, Wis.
 *E. J. WALLMAN, Great Lakes Plant, American Forge Div., American Brake Shoe & Foundry Co., Chicago, Ill.

Officers 1940-1941

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Vice-Chairman—E. C. SCHULTES, JR., C. Hager & Sons Hinge Manufacturing Co., St. Louis, Mo.
Secretary—G. H. BERRY, Western Electric Co., Hawthorne Works, Chicago, Ill.
News Letter Editor—E. W. WOODWARD, Edison General Electric Appliance Co., Inc., Chicago, Ill.
Engineering Committee—LOUIS BORAKS (*Chairman*), Liberty Mutual Insurance Co., Boston, Mass.
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 HARRY H. DAVIS, Johnson Bronze Co., New Castle, Pa.
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Industrial Data Sheet Committee—*W. J. GRAVES (*Chairman*), Michigan Mutual Liability Co., Detroit, Mich.
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 C. H. KRANTZ, Reeves Steel & Manufacturing Co., Dover, Ohio.
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 J. G. FREDERICKSON, The Chicago Hardware Foundry Co., North Chicago, Ill.
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 H. A. ZACHARI, Henry Vogt Machine Co., Louisville, Ky.
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 M. J. FELDMAN, General American Transportation Corp., Chicago, Ill.
 G. B. TYRRING, International Business Machine Corp., Endicott, N. Y.
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 H. A. McDONALD, Erie Forge Co., Erie, Pa.
 C. S. PHILLIPS, Revere Copper & Brass, Inc., Rome, N. Y.
Safety Instruction Card Committee—C. A. DEMONGE (*Chairman*), Kelsey-Hayes Wheel Co., Detroit, Mich.
 E. E. GREENE, Timken Roller Bearing Co., Canton, Ohio.
 C. F. HERBERT, Bituminous Casualty Corp., Rock Island, Ill.
 A. H. PFEIFFER, Haruuschfeger Corp., Milwaukee, Wis.
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 B. J. HINE, Scovill Manufacturing Co., Waterbury, Conn.
Members at Large—
 P. J. BRAND, Pullman-Standard Car Manufacturing Co., Pullman, Chicago, Ill.
 *H. C. HOWSAM, Hubbard Spool Co., Chicago, Ill.

*Past General Chairman

- *P. G. HUNTER, Motor Wheel Corp., Lansing, Mich.
 G. A. KUESCHENMEISTER, Dominion Forge & Stamping Co., Ltd., Walkerville, Ont., Canada.
 *T. O. MEISNER, American Can Co., Chicago, Ill.
 *B. E. ROCKHOFF, Detroit Steel Products Co., Detroit, Mich.
 *S. H. SLAYMAKER, Fairbanks Morse & Co., Beloit, Wis.
 *E. J. WALLMAN, American Brake Shoe & Foundry Co., Chicago, Ill.
 *R. M. ZELDER, Edison General Electric Appliance Co., Chicago, Ill.

*Past General Chairman

TUESDAY AFTERNOON SESSION

October 8, 1940

The opening session of the Power Press Section was called to order by General Chairman M. R. Zelder, Personnel Manager, Edison General Electric Appliance Company, Inc., Chicago, who presided. In his opening remarks the Chairman took the

opportunity to review briefly some activities of the Section during the year, and mentioned the work of many Standing Committees. Officers of the Section to serve during the coming year were elected, as listed elsewhere in this record. The Chairman then introduced the first speaker.

The Safeguarding of Fast Punch Presses

By W. A. VOLLMER

Safety Engineer, Employers Mutuals, Wausau, Wis.

Before the most practical methods of punch press guarding can be applied, it is necessary to realize why and how accidents happen.

I understand that about 85 per cent of all accidents that occur are due to either human or mechanical failures. If this is true, then the supervisor and mechanical appliances can be relied upon only to a very limited degree. If methods of die construction and of guarding can be adapted that will reduce the need for supervision and the use of mechanical movements to a minimum, the operations will be more foolproof and there will be a minimum of potential hazards.

In order to accomplish this, it should be the duty of those responsible for designing dies to try and think of some method of die construction that will enable the operator to feed the die and have some method of automatic ejection to unload the finished piece without making it necessary to place the hands at the point of operation at any time during the cycle of the operation. This can be done a large percentage of the time.

After this has been done, a basket enclosure guard can be used. This guard,

when properly made and adjusted, is stationary and surrounds the die on two sides and the front and built high enough to enclose all of the potential hazards from the holster plate up to above the clamping bolts on the ram. No moving parts being exposed, there is little chance of the operator being injured.

In most cases where basket guards are used on dies constructed as just mentioned, the operator is not only protected against being injured but the speed of the operation is increased.

There are different types of practical ejectors that can be used, such as air ejectors, pick-up ejectors, clearance ejectors and ejecting by bringing the finished piece to the top of the stroke and stripping it from the punch by aid of the knock-out bar in the ram or by stripping it with a plate stripper or stripping fingers.

One method of feeding is to use a gravity chute feed. An apron with side guides is extended to the front of the die. The die is then placed on an inclined press. The piece to be worked on is placed on the apron and slides under the basket guard that surrounds

Public Utilities Section

Officers 1939-1940

- General Chairman*—H. A. PTOLEMY, Public Service Co. of Northern Illinois, Chicago, Ill.
- Vice-Chairman*—CHARLES S. BOWDEN, Ohio Public Service Co., Alliance, Ohio.
- Secretary*—P. L. G. HASSKARI, Pennsylvania Power & Light Co., Allentown, Pa.
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*Past General Chairman

MONDAY AFTERNOON SESSION

October 7, 1940

The opening session of the Rubber Section was called to order by the General Chairman, R. W. Morse, Director, Workmen's Compensation & Safety Departments, The Firestone Tire and Rubber Company, Akron, O., who presided. The Chairman

first made a brief résumé of the activities of the Section during the past year, taking the opportunity to mention the good work of various Standing Committees. He then introduced the first speaker.

Getting Safety Off the Defensive

By A. C. HORROCKS

Public Relations Department, The Goodyear Tire & Rubber Co., Akron, O.

If you are in supervision, you were placed there because you possessed, first of all, craftsmanship; second, judgment; and third, because you were a skilled handler of men. Your most acute need then is to learn to use what you already know.

Up to the present time we haven't had a technique for men in supervision to use in handling other men. We have told them they were chosen because they had developed a fine craftsmanship. We also paid tribute to the fact that they had a keen judgment and knew how to render decisions. We also told them they were skilled handlers of men and promptly started to take away the personal contacts they had.

We decided it would be a fine thing to have a personnel director, and the hiring and the firing was taken away from the foreman. He wasn't to set any piece work prices or day rates. The time study man, the efficiency department did that. He no longer had anything to do with the purchasing of materials used in his department. The production control department estimated his needs and the purchasing department bought them. He didn't have anything to say about his monthly budget and the

breakdown of that was given to him by an accounting department. By and large, he found himself assuming the role of being responsible for his production mindedness or, in other words, he was charged with the responsibility of getting the work out.

But of the three M's of industry—Man, Material and Money—Man is by far the most important. So I am asking those in supervision to get back again to the contacts that mean so much to them and to realize that your most acute need is to learn to use what you already know. What I mean by that is that you are a skilled handler of men. The success of a safety man revolves around his contacts with the individual workmen, and the success of a production foreman likewise revolves around that workman.

We recently made a survey in seventeen cities, large, small and medium size, in various industries, to find out what the foreman's job was as he contacted men, and of the hundred and five duties that were listed we found ninety-six of them to be human contacts.

Therefore, I wonder in the promotion of danger consciousness if we have seriously

asked some of the following questions. They will get glorious results for us if we will follow a plan:

What makes this employee tick? If I am going to make him safe while he is in my employ, I must know him.

What is his education? What experience has he had prior to coming to me?

Then you should ask and be satisfied to know, what are his tendencies toward society; toward work and toward management?

What is his temperament? Is he the kind of a fellow when things get going a little bit tough who will be the emotional type, who blows up, or is he the plodder type that you can count on and rely on in an emergency, like a fire, and know full well you have a level-headed man pitching for you who will do exactly what you told him to do?

What are his supervisory needs? If you have a hundred men working for you no two have the same needs when it comes to supervision.

How does he present his problems to me? That tells me a lot about how that man's mind works.

How must I approach him? What plan of progress have I made for him?

How important it is in this new day because there is a pattern or common procedure, which applies to all foremen-workmen contacts, and it is as fine and swift in the final conclusion as the steps to a sale, which are: Favorable attention, interest, appreciation of value, desire, decision, action, satisfaction, confidence.

My next statement is probably one that you would like to challenge until you hear the explanation. Listen carefully: Production-mindedness is at once an asset and a liability. An asset when service is cheerfully built into the product, and pride in what is turned out, because we know the consuming public is able to get out of the article the service we built into it. A liability when our drive is emphasized and men are considered as only a cog in the machine, when we ignore the human feelings and the human element.

So it seems to me the production-minded supervisor in this new technique, in order to make men conscious of what they owe society, in order to make it a sacred place, in order to make them conscious of danger,

has to step up to a man and give him a wholesome greeting with a smile. It doesn't cost much. That is the initial step. That corresponds with the salesman getting favorable attention from his prospect.

Then you are going to create the proper atmosphere before you start to talk to that man about the job. If you are in supervision, if you are up there because of your craftsmanship, your judgment and because you are a skilled handler of men, you must take a step down to that fellow's level when you step in to create atmosphere. He can't come up to you in your thinking, in your planning or in your conversation. You might be thankful he can't. If he could he would be competition for your job. It is necessary for you to come down to his level.

Then the next thing you can ask yourself is what are the dangers of the job; and that doesn't only mean physical dangers. It takes in mental dangers and you can watch that man's attitude and help to lift the worry from his mind.

A short time ago we had one of the general foremen notified that an employee of eleven years' service in his department had broken the machine for the third time. Now, Jack was a big raw-boned Pennsylvania Dutchman, who stood about six feet and weighed about 225 pounds, and there was no fat on him. He was the kind of a fellow who had come up from the ranks years ago. He knew his job, he thought he knew how to handle men.

Jack had listened to some of this development, and he remembered a chance statement made by the lecturer to the Goodyear supervisors. He had happened to say those words: "Remember, foreman, a good man doesn't go wrong in a few days' time without there being a sufficient reason."

So Jack said, "All right," to the inspector who had just brought the news to him, "I will fix him," and out of his office he went and came over toward the workman standing with his back up to the window, contemplating the destruction of the machine. Jack took in the picture and he walked a little more slowly, then this thought flashed into his mind: "A good man doesn't go to pieces in a short time without a good reason." He said, "Jim, it looks to me as though you had had a pretty rough night at sea last night. This is the third time this week that you have smashed this machine."

ing rooms as they are less susceptible to the rashes. The dark skin races appear to be resistant to dermatitis causing materials. In cases where the vapor or gas given off is a cause, ventilation will help. Protective clothing and gloves may be worn on some jobs. The use of protecting creams is being tried. This should be watched with great care. A cream may collect and increase the strength of the material causing the rash. The use of a bland cream during non-working hours may improve the skin to the point where it may better resist the disturbing material.

Cleanliness, an ideal for all health hazards, is just as important in the rubber industry for protection against dermatitis as any element. This refers to the cleanliness of the machine, the workroom and the worker. In connection with this reference to cleanliness, your attention is called to the paper presented by Drs. Klauder and Gross at the Health Service in Industry Section a year ago which appears in the Transactions of the 28th National Safety Congress. The

paper is well worth the time it takes to read it.

Reference has been made to plastics and plasticisers. Up to the present time, I have had very little to do with these materials but I hear a little here and a little there. Many of these materials are synthetic in origin and when not properly handled and used may cause dermatitis.

A factor of increased sensitization has been mentioned in connection with dermatitis from organic accelerators. Patch testing has done considerable to hear out this contention. A person who has been slow in giving a reaction to the first test, may later become hypersensitive to the materials used. In fact, some workers have been forced to give up the line of work they are doing because a return to work causes an immediate recurrence of the rash, usually in an aggravated form.

Variations of reactions in varying seasons may be noticed. We often see a little epidemic of rashes in the spring where the same people have worked for months on the same material.

ADJOURNMENT

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TUESDAY AFTERNOON SESSION

October 8, 1940

The opening session of the Steam Railroad Section was called to order by the Chairman, E. L. Henry, Superintendent of Safety, Chicago & North Western Railway Company, Chicago, who presided.

He outlined briefly some of the activities of the Section during the past year, and took

the opportunity to mention the work of many Standing Committees. He then introduced J. R. Tenney, Supervisor of Safety, Western Maryland Railway Company, Packerstown, Md., Chairman of the Program Committee, who assumed the Chair. Tenney introduced the speakers.

The Effectiveness of Grade Crossing Protective Devices from the Viewpoint of State Authorities

By WARREN HENRY

Assistant Chief Engineer, Illinois Commerce Commission, Springfield, Ill.

The art of grade crossing protection has made rapid advance in the past few years and I believe it is fair to say that the state of public opinion on this point has advanced fully as much. It was not long ago for instance that a major obstacle to progress in

this field seemed, to some of us at least, the prevalence of what was often called the claim agent point of view, that is an emphasis upon legal liability rather than public safety.

Another very persistent mental attitude

which I think is definitely on the way out, is that we are only concerned with giving highway users and especially automobile drivers a fair warning, that he may avoid getting hurt or killed on a crossing, and that it is no concern of the public authority whether the driver obeys or disregards warnings so given. Right here is a division between the liability and the public safety point of view.

Very possibly the victim of an accident (and he may be only one of the victims) has been so negligent as to be chargeable with the disaster. It may have been his fault, but the occurrence was by no means his own fault and the business of no one else.

There has been altogether too abundant demonstration of the fact that it is quite possible for anyone to drive an automobile on the path of or against a railroad train on a crossing without injuring, or at least passing upon, the rights of others. Trains have been wrecked many times by such a proceeding and both passengers and members of the crew killed or injured.

A collision recently occurred in which a train struck a small truck at a grade crossing adjacent to the business district of central Illinois city. The streets were full of people. The truck was totally demolished and the two occupants killed. The motor of the truck was thrown through the air and landed violently against the side of a hotel. There is no doubt that the guests and employees of this hotel who were thus endangered, as well as numerous other people in the vicinity had an interest in the transaction that regardless of who was at fault, public safety had been gravely endangered.

Another thing which is somewhat of a stumbling block is a confusion between occurrence of accidents and public safety. Members of the public can be in very grave danger without an accident actually happening. The practical importance of this lies in the common disposition to regard the accident record at a particular crossing as the measure and measure of hazard. Not that accident record can be disregarded altogether; but where we are working fundamentally for the public safety the major emphasis should be upon producing conditions that accord with safety rather than remedial measures designed to meet the combinations of events.

The primary purpose of grade crossing protective devices is to promote public safety, that is to reduce the exposure of the public to conditions of hazard. In that fundamental view there should be no difference of opinion between state authorities and anyone else, railroads or others who are dealing with this problem.

The factors which make for effectiveness or non-effectiveness are not all mechanical ones. Many of them are human factors, and are not as readily subject to control as are the mechanisms employed. The fact that there are human factors, however, is not a matter that can be disregarded, and moreover it does not follow that human factors may not be dealt with, anticipated, studied, and, to some extent, controlled.

This is a very essential aspect from the standpoint which I am endeavoring to present. From this standpoint we are not so much concerned with what ought to happen as with what does generally happen; not depending so much on what a motorcar driver ought to do as what the ordinary human being is likely to do; not dealing with a theoretical personage, who is at all times vigilant, watchful, alert and has his mind on what he is doing, but rather with the common ordinary run of mortals who are subject to shortcomings, frailties, lapses and infirmities which are the common heritage of mankind and also of womankind.

An accident occurred near the outskirts of a small city in western Illinois at the crossing of a minor, gravel surfaced local street, with the tracks of a main line railroad. The crossing was marked only by regulation crossbuck signs and it was not such a crossing as would usually be protected by gates or signals. An oncoming train would be clearly visible for a distance of something like a mile at all points along the street within some 300 feet from the crossing. The driver of the car was a local resident. Accompanied by his wife and their four children he was on an ordinary neighborhood errand, shortly after one o'clock in the afternoon. They stopped at a house near the crossing, where a neighbor joined the party and then the car proceeded first to make a right angle turn onto the graveled street, some 220 feet from the crossing, and then to drive this 220 feet to the crossing in full view of an approaching local freight train. It seems quite impossible that the

INDEX

A

Accident Statistics: Fundamental Causes of Accidents. Panel Discussion, 91-105.
 Practical Uses of Accident Cost Data in the Safety Program (Draper), 564-569.
 Practical Uses of Accident Cost Data in the Safety Program (Grant), 563-564, 566-569.
 Adams, O.: Water Utility, 644-646.
 Aeronautical Section: Minutes, 285-300.
 Officers, 285.
 Aeronautics: Copilot Material and Training (Bryan), 295-296.
 Proposals for Safe Regulation of Charter Operator (Whitney), 292-294.
 Regulation of the Charter Operator (Lederer), 288-292.
 Training Mechanics for Safe Air Transport Operation (Healey), 297-299.
 Training Mechanics for Safe Air Transport Service (Smith), 299-300.
 Uniform Airport Traffic Control (Berry), 285-287.
 "After the Whistle Blows": Contests and Cooperation. Panel Discussion, 186-187.
 Cooperation with Public Officials. Panel Discussion, 193-196.
 The Value of After-Work Safety Lectures. Panel Discussion, 187-189.
 The Value of "Off-Duty" Safety Programs. Panel Discussion, 183-185.
 Agricultural Safety Session: 29-46.
 A.S.S.E.-Engineering Section: Minutes, 301-304.
 Officers, 301-302.
 Anderson, K. H.: Interest of Rural Youth Organizations in Farm Safety, 41-42.
 Annual Meeting of Members, 11-26.
 Aprons: See Clothing.
 Armstrong, T. O.: Ask the Employee, 492-495.
 Automotive and Machine Shop Section: Minutes, 305-318.
 Officers, 305-306.
 Automotive and Machine Shop--Power Press Section: Joint Session, 313-318.

B

Bales, E.: How the Public and Authorities Can Aid in the Railroad Safety Program, 720-722.
 Banquet, 27-28.
 Barker, M. I.: Nutrition for Industrial Workers, 148-150.
 Bates, G. J.: Correcting Unsafe Practices Through Methods Study, 630-633.
 Bergen, A. A.: Safety Accomplishments During the Past 25 years by an Old Timer, 522-527.
 Bosty, D. H.: The Public Aspects of Grade Crossing Accidents, 707-709.
 Budge, F. E.: A Course of Training Foremen for Safety Work, 499-502.
 Buis: Safety: Important Factors in Testing Safety Belts (James), 247-250.
 Safety Belt Anchors--Design, Quality, Placement and Maintenance (Manex), 245-247.
 Safety Belt Materials (Soutar), 250-252.
 Bowman, H. H.: Coal Bunker Case, 646-647.
 Berry, Maj. J.: Uniform Airport Traffic Control, 285-287.

Bethune, F.: Textile Safety Through the Plant Nurse, 728-730.
 Boardman, J. L.: What Should a Mine Safety Inspector Look For? 516-519.
 Bonesteel, Brig. Gen. C. H.: Safety and War, 15-17.
 Boughner, C. A.: What the Foreman Can and Cannot Do for Safety, 253-257.
 Braun, F. W.: Review of 1939-40 Accident Experience, 557-562.
 Breweries: Safe Practices in Refrigeration of Breweries (Kiernan), 663-665.
 Brown, A. L.: Spontaneous Ignition and Its Control, 82-86.
 Bryan, O.: Copilot Material and Training, 295-296.
 Building Maintenance Session: 47-62.
 Burger, J. J.: Eliminating the Causes of Textile Accidents, 730-732.
 Burns: Why Can a Small Electric Burn Cause Death When Large Burns from Flames Do Not? Panel Discussion, 385.

C

Cadman, R. M.: The Problem of Underground Service Station Tanks, 614-620.
 Cameron, W. T.: Standardizing State Industrial Safety Requirements, 115-117.
 Cement and Quarry Section: Minutes, 319-326.
 Officers, 319-320.
 Cement Industry: Analysis of Cement and Quarry Industry Accident Experience (LeGore), 320-323.
 Creating a Safe Working Force. Panel Discussion, 325-326.
 Physical Control of Accident Hazards. Panel Discussion, 323-324.
 Chains: Chain Block and Chain Inspection. Panel Discussion, 392-393.
 Chemical Industry: The Safe Disposal in Chemical Plants of Empty Containers Including Tanks, Drums, Cans, Bottles, Gas Cylinders, Dismantled Equipment, and Old Pipe Lines (Jones), 341-346.
 The Use of Rubber and Rubber Compounds in the Chemical Industry (True), 328-333.
 Chemical Section: Contest, 336-338.
 Minutes, 327-351.
 Officers, 327-328.
 Child Safety: How to Enlist the Support of School Children in Accident Prevention (Meyers), 717-718.
 Clarke, J. O.: Safety Requirements of the Federal Food, Drug and Cosmetic Act, 377-381.
 Clothing: Aprons and Gloves for Employees Using Cutlery. Panel Discussion, 439.
 Personal Protective Equipment Suitable for Men Handling Lumber. Panel Discussion, 740-741.
 Safety Shoes. Panel Discussion, 437-438, 440.
 Safety Shoes for Wood Handlers, 580.
 Coal: Coal Bunker Case (Berman), 646-647.
 Colleges and Universities: Interest of Agricultural Colleges in Farm Safety (Lehmann), 42-45.
 Commercial Fleets: See Drivers and Driving.
 Committees: Safety Committees. Panel Discussion, 154-157.

Construction Industry: The Maintenance of First Aid Units for Compressed Air Workers (Requarth), 367-371.
 Organizing a Steel Erection Job for Safety (Hazard), 354-358.
 Safety Features in the Construction of Hiwassee Dam (Walters), 372-374.
 Safety Pays Dividends (Cowper and Locher), 363-367.
 See also Ship-building.
 Construction Section: Minutes, 353-371.
 Officers, 353-354.
 Contests: Chemical Section, 336-338.
 A Competitive Safety Program that is Working (Sturtevant), 726-728.
 Marine Section, 425-426.
 Metals Section, 461-463.
 Methods of Developing a Competitive Safety Program (Monroe), 724-726.
 Paper and Pulp Section, 581-583.
 Petroleum Section, 622-624.
 Plant Safety Contests. Round Table Discussion, 584-588.
 Presentation of the Edward Benton Fritz Memorial Trophy, 582-583.
 Public Utilities Section: 649-650.
 Rubber Section, 679-680.
 Safety Contests, 160-162.
 Contusions: The Control of Sprains and Strains (Wittmer), 121-125.
 Conveyors: Safe Handling of Bulk Materials (Robertson), 554-557.
 Corbett, W. A.: Lessons from Safety Experience, 647-649.
 Cowper, J. W. and Locher, H. O.: Safety Pays Dividends, 363-367.
 Cranes: Analysis of a Locomotive Crane Accident. Panel Discussion, 92-97.
 Electrical Hazards of Overhead Traveling Cranes (Schlossberg), 199-201.
 Cylinders: The Safe Disposal in Chemical Plants of Empty Containers Including Tanks, Drums, Cans, Bottles, Gas Cylinders, Dismantled Equipment, and Old Pipe Lines (Jones), 341.

D

Dairy Products: See Milk and Dairy Products.
 Dams: See Construction Industry.
 Davidson, Dr. M.: Industry's Obligation to More Adequately Protect the Worker's Eyesight, 63-67.
 Davis, H. G.: Work of the Farm Equipment Institute in Farm Safety, 34-36.
 Derby, W. N.: Safety Education and the Training of Seamen, 418-420.
 Dermatitis: See Health Hazards.
 Detectors: See Gases.
 Discipline: Panel Discussion, 451-455.
 Doors: Swinging and Revolving Doors in Public Buildings, 50, 53, 56-57.
 Draper, J. A.: Practical Uses of Accident Cost Data in the Safety Program, 564-569.
 Drivers and Driving: Analysis of a Truck Driver Accident. Panel Discussion, 101-103.
 Are Women Worse Drivers than Men? 196.
 The I.C.C. Drivers' Log. Panel Discussion, 384-385.
 What is Speeding? Panel Discussion, 395-396.
 Drums: See Tanks and Drums.
 Duggan, J. E.: Accident Prevention Through Periodic Test and Inspection of Machinery and Equipment, 333-336.
 Dusts: Dust Cleaning Equipment. Panel Discussion, 387-388.
 Maximum Allowable Concentrations of Dangerous Dusts and Gases (Hamilton), 110-114.
 Pulmonary Diseases in the Mining Industry (Sayers), 530-548.

E

Eaton, R. S.: Accident Prevention Through First Aid, 733-735.
 Economics of Safety: An Executive Looks at Safety (Nagler), 638-641.
 Safety Pays Dividends (Cowper and Locher), 363-367.
 Education of Workmen: A Course of Training Foremen for Safety Work (Bedale), 499-502.
 Methods and Techniques. Panel Discussion, 261-276.
 The Training Program. Panel Discussion, 265-276.
 Electrical Equipment: Hazards and Proper Maintenance of Portable Electrical Equipment (Shepard), 346-351.
 Electrical Industry: See Public Utilities.
 Electricity: Effect of Electric Current. Panel Discussion, 388-389.
 Elevators: Elevator Problems, 57-61.
 Employees: Ask the Employee (Armstrong), 492-495.
 Enlisting Employees in the Accident Prevention Program. Panel Discussion, 600-610.
 Merit Rating Systems, 267-269.
 Methods of Maintaining the Interest of Management and Employees. Panel Discussion, 151-154.
 Employees Training: See Education of Workmen.
 Employers' Publications: How Large Should a Plant be Before it Has a House Organ? Panel Discussion, 385-386.
 Engineering: Correcting Unsafe Practices Through Methods Study (Bates), 630-633.
 Safety in Original Design (North), 676-679.
 Engineers: Confessions of a Consulting Safety Engineer (Goldstine), 360-363.
 See also Supervisors.
 Erickson, T. A.: Minnesota 4-H Clubs Safety Program, 39-41.
 Executives: See Management.
 Exhibits: Safety Exposition Exhibitors, 743-747.
 Eye Protection Session: 63-77.
 Eyes: Defective eyesight as a Contributing Cause of Accidents, 76-77.
 Eye Examination Program, 66-67.
 In What Operations and Occupations do Eye Injuries Occur Most Frequently? 68-69.
 New Concepts of Visual Performance in Industry (Kuhn), 129-131.
 Visual Acuity and Job Placement, 75-77.
 See also Goggles.

F

Falls: Persons: Percentage of Women having Accidents, Compared to Men, 53.
 Slippery Floors, Rugs and Mats as Accident Causes in Public Buildings, 50-54.
 Farm Safety: Farm Accidents—Why They Occur and Who is Responsible for Corrective Action (Mohler), 29-33.
 Governmental Interest in Farm Safety (McCrory), 37.
 Interest of Agricultural Colleges in Farm Safety (Lehmann), 42-45.
 Interest of American National Red Cross in Farm Safety (Thrush), 37-39.
 Interest of Rural Youth Organizations in Farm Safety (Anderson), 41-42.
 Minnesota 4-H Clubs Safety Program (Erickson), 39-41.
 Work of the Farm Equipment Institute in Farm Safety (Davis), 34-36.
 Work of the Illinois Agricultural Association in Farm Safety (Seagraves), 33-34.
 Fatigue: Fatigue and Its Relation to Occupational Disease. Panel Discussion, 169-172.

Federal Departments: The Coast Guard Reserve A Safety Organization (Waesche), 409-411.
 Safety Activities of the U. S. Army Engineers: Problems and Proposed Solutions (Vanderventer), 400-402.
 Fire Control and Prevention Session: 79-90.
 Fire Protection: Dust Cleaning Equipment. Panel Discussion, 387-388.
 Experience with the Water Spray for Fighting Oil Fires. Panel Discussion, 383-384, 386.
 Industrial Fire Drills, 390-392.
 Precautions to be Taken by Users of Hand Fire Extinguishers (Lange), 86-90.
 Spontaneous Ignition and Its Control (Brown), 82-86.
 What Fires of Last Year Have Taught Us (Fleming), 79-82.
 When and Where and if So, What Fire Regulations are Needed for Producing Fields? (Prussing), 598-600.
 First Aid: Accident Prevention Through First Aid (Eaton), 733-735.
 First Aid Training as an Aid in Promoting Accident Prevention (Fisher), 119-121.
 Fisher, Dr. H. E.: First Aid Training as an Aid in Promoting Accident Prevention, 119-121.
 Fleming, T. A.: What Fires of Last Year Have Taught Us, 79-82.
 Floors: Slippery Floors, Rugs and Mats as Accident Causes in Public Buildings, 50-54.
 What Types of Floor Surfaces Tend to Reduce Slipping. Panel Discussion, 440-441.
 Food: Nutrition for Industrial Workers (Barber), 148-150.
 Food Industry: Eliminating Accident Hazards in Soybean Processing (Schwarcman), 381-382.
 Experience with the Water Spray for Fighting Oil Fires. Panel Discussion, 383-384, 386.
 Safety Requirements of the Federal Food Drugs and Cosmetic Act (Clarke), 377-381.
 Food Section: Minutes, 375-396.
 Officers, 375-377.
 Foremen: A Course of Training Foremen for Safety Work (Bedale), 499-502.
 How Convert the Foreman? 274-276.
 What the Foreman Can and Cannot Do For Safety (Boughner), 253-257.
 See also Supervisors.
 Foundries: See Metal Industries.
 Fuel: See Coal.
 Fundamental Causes of Accidents Session: 91-105.

G

Geijens, A. K.: Light—Antidote for Accidents, 125-128.
 Garbutt, W. C.: Physical Examinations—Standard Requirements—Expense, 405-407.
 Gases: Advantages That Have Been Gained Due to the Invention and Use of Methane Detectors (Zorn), 527-530.
 Maximum Allowable Concentrations of Dangerous Dusts and Gases (Hamilton), 110-114.
 Gloves: Safety in the Manufacture of Leather Gloves (Granniss), 432-435.
 See also Clothing.
 Goggles: Does a Deposit Charge for Goggles Tend to Keep the Men from Using Them? Panel Discussion, 457-458.
 Mining Experience, 73-74.
 The Pro and Con of the Compulsory Goggle Rule, 69-72.
 See also Eyes.
 Goldstine, E. N.: Confessions of a Consulting Safety Engineer, 360-363.
 Governmental Safety Service in Industry Session: 107-117.
 Grade Crossings: The Effectiveness of Grade Crossing Protective Devices from the Viewpoint of State Authorities (Henry), 698-702.

Effectiveness of Grade Crossing Protective Devices from the Viewpoint of the Railroad Engineering Department (Post), 702-707.
 Enforcement as a Factor in Grade Crossing Safety (Kreml), 710-711.
 The Public Aspects of Grade Crossing Accidents (Healy), 707-709.
 Granniss, E. R.: Safety in the Manufacture of Leather Gloves, 432-435.
 Grant, E. E.: Practical Uses of Accident Cost Data in the Safety Program, 563-564, 566-569.
 Griffin, G. O.: Hazards of River Transportation, 407-408.
 Guards: Safety in Original Design (North), 676-679.
 Specify the Safeguards (Thiede), 307-309.
 Gurley, F. G.: The Public's Responsibility in the Railroad Safety Problem, 712-715.
 Gymnasiums: Floors in Gymnasiums, 53-54.

H

Hamilton, Dr. A.: Maximum Concentrations of Dangerous Industrial Dusts and Gases, 110-114.
 Handling Materials: Safe Handling of Bulk Materials (Robertson), 554-557.
 Safe Handling of Unit Materials (Long), 552-554, 556-557.
 Hazard, W. A.: Organizing a Steel Erection Job for Safety, 354-358.
 Head Protection: What Protective Equipment Should be Worn to Prevent Head Injuries. Panel Discussion, 435-436.
 Healey, T. J.: Training Mechanics for Safe Air Transport Operation, 297-299.
 Health Hazards: Cleaning Gasoline Storage Tanks Used for Leaded Gasoline (Lewis), 593-598.
 Dermatitis in the Rubber Industry (Uletz), 688-692.
 Discussion of Dermatitis (Shirley), 692-696.
 Fatigue and Its Relation to Occupational Disease. Panel Discussion, 169-172.
 Health Hazards in Spray Painting. Panel Discussion, 165-169.
 The Heart and Heart Disease in Industry (Miller), 144-147.
 Lead in Industrial Processes. Panel Discussion, 174-177, 181.
 The Maintenance of First Aid Units for Compressed Air Workers (Requarth), 367-371.
 Maximum Allowable Concentrations of Dangerous Industrial Dusts and Gases (Hamilton), 110-114.
 Protection for Welders, 180-181.
 Pulmonary Diseases in the Mining Industry (Sayers), 530-548.
 Should Occupational Diseases be Considered as Industrial Injuries? Panel Discussion, 178-180.
 Skin Affections. Panel Discussion, 177-178, 181.
 The Toxic Limits of Common Solvents. Panel Discussion, 172-174, 176-177, 181-182.
 Traumatic Neurosis (Pollock), 135-139.
 Health Service in Industry Session: 119-128.
 Henrie, H. C.: The Necessity of Active Participation of Management in Safety Work, 508-511.
 Henry, W.: The Effectiveness of Grade Crossing Protective Devices from the Viewpoint of State Authorities, 698-702.
 Hickok, S. C.: Safety Successes in the Textile Industry Are Recognized, 736-738.
 Home Safety: Home Safety Inspections. Panel Discussion, 192-193.
 Horrocks, A. C.: Getting Safety off the Defensive, 672-676.
 Hospitals: What are the Common Causes of Accidents in Public Buildings and How Can They be Corrected? Panel Discussion, 49-62.

Hoods: What are the Common Causes of Accidents in Public Buildings and How Can They be Corrected? Panel Discussion, 19-62.

See also Public Buildings.

House Organs: See Employees' Publications. Housekeeping: Plant Housekeeping. Round Table Discussion, 588-589.

Safety Stunts That Have Helped Maintain Good Housekeeping. Panel Discussion, 113. Stumble Costs Two Fingers. Panel Discussion, 480-483.

Hulbert, Dr. H. S.: Psychology and Safety. Lectures, 209-243.

Human Element: See Personal Factors.

Hulbutt, F. L.: Ups and Downs; Some Facts About Ladders, 358-360.

I

Ice: See Refrigeration.

Ice Cream: See Milk and Dairy Products.

Industrial Nursing Session: 129-150.

Industrial Relations: Ask the Employee (Armstrong), 492-495.

Employee Welfare Systems, 163-164.

Inspection: Accident Prevention Through Periodic Test and Inspection of Machinery and Equipment (Duggan), 333-336.

Chain Block and Chain Inspection. Panel Discussion, 392-393.

How Safety Inspections Prevent Accidents (Storey), 416-417.

Parking and Inspection of Employees' Cars. Panel Discussion, 189-192.

Preventing Power Press Accidents Through Periodic Machine Inspections (McDonald), 309-311.

What a Mine Safety Inspector Should Look for in Bituminous Coal Mines (Lindley), 520-522.

What Should a Mine Safety Inspector Look For? (Boardman), 516-519.

What Should an Anthracite Mine Safety Inspector Look For? (Peterson), 511-516.

Insurance: Accident Prevention Through the Eyes of an Insurance Executive (MacDonald), 620-622.

Investigation of Accidents: 254-256.

Accident in Plate Mill. Panel Discussion, 171-177.

Accident on Coal Bridge. Panel Discussion, 188-191.

A Coupling Accident. Panel Discussion, 183-188.

Fundamental Causes of Accidents. Panel Discussion, 91-105.

The Safety Supervisor's Part in the Investigation of Accidents (Zeilinger), 257-259.

Slitting Machine Accident. Panel Discussion, 177-180.

Stumble Costs Two Fingers. Panel Discussion, 480-483.

J

James, S. V.: Important Factors in Testing Safety Belts, 247-250.

Jones, C. L.: The Safe Disposal in Chemical Plants of Empty Containers Including Tanks, Drums, Cans, Bottles, Gas Cylinders, Disassembled Equipment, and Old Pipe Lines, 111-116.

Jones, J. E.: What Do We Actually Know About Roof Testing? 501-507.

K

Kiernan, B. L.: Safe Practices in Refrigeration of Breweries, 663-665.

Kreml, Lieut. F. M.: Enforcement as a Factor in Grade Crossing Safety, 710-711.

Kuhn, Dr. H. S.: New Concepts of Visual Performance in Industry, 129-131.

L

Ladders: Ups and Downs; Some Facts About Ladders (Hulbutt), 358-360.

Lange, H. W.: Precautions to be taken by Users of Hand Fire Extinguishers, 86-90.

Le Gore, L. E.: Analysis of Cement and Quarry Industry Accident Experience, 320-323.

Lead: Cleaning Gasoline Storage Tanks Used for Leaded Gasoline (Lewis), 593-598.

Leather Industries: Safety in the Manufacture of Leather Gloves (Gramiss), 432-435.

Leather Industries Section: See Meat Packing, Tanning and Leather Industries Section.

Ledbetter, R. C.: Hazards of Car Ice and Their Elimination, 660-663.

Lederer, J.: Regulation of the Charter Operator, 288-292.

Lee, J. H.: The Use of Visual Aids in Accident Prevention, 278-280.

Lee, Com. R. C.: Train Seamen for American Ships, 423-425.

Lehmann, E. W.: Interest of Agricultural Colleges in Farm Safety, 42-45.

Lewis, O. B.: Cleaning Gasoline Storage Tanks Used for Leaded Gasoline, 593-598.

Lifting: The Control of Sprains and Strains (Wittmer), 121-125.

Lighting: Light Antidote for Accidents (Gaetjens), 125-128.

Lindley, J. L.: What a Mine Safety Inspector Should Look for in Bituminous Coal Mines, 520-522.

Linemen: Lessons from Safety Experience (Corbett), 647-649.

Logging: See Wood Products Industry.

Long, J. A.: Safe Handling of Unit Materials, 552-554, 556-557.

Mc

MacDonald, R. R.: Accident Prevention Through the Eyes of an Insurance Executive, 620-622.

MacEachern, Dr. M. T.: The Industrial Nurse's Perspective, 140-143.

McCrory, S. H.: Governmental Interest in Farm Safety, 37.

McDonald, J. C.: Preventing Power Press Accidents Through Periodic Machine Inspections, 309-311.

McLean, F. R.: The Effects of Legislative Trends on Safety, 610-614.

M

Maintaining Interest in Safety: Maintaining Safety Interest in the Small Plant (Wilson), 461-464.

Methods of Maintaining the Interest of Management and Employees. Panel Discussion, 151-154.

Promoting Safety Consciousness Among Lumbering and Logging Operators. Panel Discussion, 571-576.

Maintaining Interest in Safety Session: 151-161.

Maintenance: See also Building Maintenance. Management: Conserving Our Greatest Asset—Man Power (Mitchell), 18-26.

The Education of Ship Owners in Safety (Martinson), 402-404.

An Executive Looks at Safety (Nagler), 638-641.

Management and Employee Responsibility in the Prevention of Personal Injuries (Miner), 338-341.

Management's Responsibility for Safety (Rohrer), 628-630.

Methods of Maintaining the Interest of Management and Employees. Panel Discussion, 151-154.

The Necessity of Active Participation of Management in Safety Work (Henrie), 508-511.

Mans, J. L.: Safety Belt Anchors Design, Quality, Placement and Maintenance, 215-247.

Marine Industry: The Coast Guard Reserve—A Safety Organization (Waesche), 409-411.

The Education of Ship Owners in Safety (Martinson), 402-404.

The Future Safety of the American Merchant Marine (Pearsall), 420-423.

Hazards of River Transportation (Griffin), 407-408.

How Safety Inspections Prevent Accidents (Storey), 416-417.

Kapok Jackets for River Work, 401.

Safety Education and the Training of Seamen (Derby), 418-420.

Safety in Ship Design and Construction (Vickery), 412-416.

Train Seamen for American Ships (Lee), 423-425.

Marine Section: Contest, 425-426.

Minutes, 397-426.

Officers, 397-426.

Martinson, G.: The Education of Ship Owners in Safety, 402-404.

Maskell, J. E.: The Railroads' Anti-Trespass Program, 718-720.

Meat Packing Industry: Aprons and Gloves for Employees Using Cutlery. Panel Discussion, 109-111.

Safety in Handling Live Stock (Smith), 428-431.

Safety in the Meat Packing and Tanning Industries. Panel Discussion, 435-444.

Shipping Accidents. Panel Discussion, 439-441.

Meat Packing, Tanning and Leather Industries Section: Minutes, 427-444.

Officers, 427.

Mercantile Establishments: What are the Common Causes of Accidents in Public Buildings and How Can They be Corrected? Panel Discussion, 49-62.

Meat Industries: Accident in Plate Mill. Panel Discussion, 471-477.

Accident on Coal Bridge. Panel Discussion, 188-191.

Accident Prevention in the Steel Industry (Foweraker), 458-461.

Analysis of a Steel Plant Accident. Panel Discussion, 97-101.

How to Build a Safety Program for the Small Foundry (Rentschler), 467-470.

Safety an Operating Problem. Panel Discussion, 171-191.

Slitting Machine Accident. Panel Discussion, 177-180.

Metals Section: Contest, 461-463.

Minutes, 445-495.

Officers, 445-495.

Meyers, Lieut. H. E.: How to Enlist the Support of School Children in Accident Prevention, 717-718.

Milk and Dairy Products: Safe Practices in Dairy and Ice Cream Plants (Quessell), 645-666.

Miller, Dr. J. R.: The Heart and Heart Disease in Industry, 144-147.

Miner, E. S.: "How it Happened," 642.

Miner, H. L.: Management and Employee Responsibility in the Prevention of Personal Injuries, 338-341.

Mining Industry: Advantages That Have Been Gained Due to the Invention and Use of Methane Detectors (Zorn), 527-530.

Goggle Experience in the Mining Industry, 71-71.

The Necessity of Active Participation of Management in Safety Work (Henrie), 508-511.

Pulmonary Diseases in the Mining Industry (Sayers), 530-546.

Safety Accomplishments During the Past 25 Years by an Old Timer (Bawden), 522-527.

What a Mine Safety Inspector Should Look for in Bituminous Coal Mines (Lindley), 520-522.

What Do We Actually Know About Roof Testing? (Jones), 502-507.

What Should a Mine Inspector Look For? (Boardman), 516-519.

What Should an Anthracite Mine Safety Inspector Look For? (Peterson), 511-516.

Mining Section: Minutes, 497-548.

Officers, 497-498.

Minor Injuries: The Control of Sprains and Strains (Wittmer), 121-125.

Mitchell, W. E.: Conserving Our Greatest Asset—Man Power, 18-26.

Mohler, J. C.: Farm Accidents Why They Occur and Who is Responsible for Corrective Action, 29-33.

Monroe, P. J.: Methods of Developing a Competitive Safety Program, 724-726.

Morris, F.: Why Should We Prevent Accidents in Public Buildings? 47-49.

Motion Pictures: See Visual Education.

Motor Vehicle Industry: Accident Prevention Measures (Mould), 311-313.

Motor Vehicles: Parking and Inspection of Employees' Cars. Panel Discussion, 189-192.

Mould, D.: Accident Prevention Measures, 311-313.

Municipal Employees: See Public Employees.

N

Nagler, K. B.: An Executive Looks at Safety, 638-641.

National Defense: Conserving Our Greatest Asset—Man Power (Mitchell), 18-26.

Safeguarding Manpower for Greater Production (Zimmer), 107-110.

Safety and War (Bonesteel), 15-17.

National Safety Council: Directors, 5-8, 14-15.

Executive Committee, 4-5.

Honorary Members, 4.

Nominating Committee Report, 14-15.

Officers, 4, 27.

President's Annual Address (Stillwell), 11-14.

Purposes and Programs, 9-10.

Resolutions Committee Report, 25-26.

Noise: Effect of Factory Noise in Regard to Fatigue, 171.

North, R. A.: Safety in Original Design, 676-679.

Nurses: The Industrial Nurse's Perspective (MacEachern), 140-143.

Nutrition for Industrial Workers (Barber), 118-150.

Textile Safety Through the Plant Nurse (Bethune), 728-730.

Nurses Session: See Industrial Nursing Session.

O

- Obetz, Dr. W. E.: Dermatitis in the Rubber Industry, 688-692.
Occupational Disease Session: 165-182.
Off-the-Job Accidents Session: 183-196.
Office Buildings: What are the Common Causes of Accidents in Public Buildings and How Can They be Corrected? Panel Discussion, 49-62.
Organization: Enlisting Employees in the Accident Prevention Program. Panel Discussion, 600-610.
Organizing a Small Group. Panel Discussion, 194-195.
Organizing a Steel Erection Job for Safety (Hazard), 351-358.

P

- Packing Industry: See Meat Packing Industry.
Paint: Health Hazards in Spray Painting. Panel Discussion, 165-169.
Paper and Pulp Section: Contest, 581-583. Minutes, 549-590.
Paper and Pulp: Wood Products Sections: Joint Session, 569-581.
Paper Industry: Nip Hazards, 559-562.
Practical Uses of Accident Cost Data in the Safety Program (Draper), 564-569.
Practical Uses of Accident Cost Data in the Safety Program (Grant), 563-564, 566-569.
Review of 1939-40 Accident Experience (Braun), 557-562.
Safe Handling of Unit Materials (Long), 552-554, 556-557.
Safety from Woods to Mill. Panel Discussion, 672-581.
See also Wood Products Industry.
Parking: Parking and Inspection of Employees' Cars. Panel Discussion, 189-192.
Parxall, C. H. C.: The Future Safety of the American Merchant Marine, 420-423.
Personal Factors: Effect of World Unrest. Panel Discussion, 393-394.
How Does Personality Affect Your Accident Record? Panel Discussion, 384, 389-390.
Human Behavior and Safety (Schaefer), 313-318.
Mental Hygiene and Individual Differences Complicated by Divided Loyalties and the Unusual Stresses of the Times (Hulbert), 228-235.
Mental Hygiene of the Industrial Worker (Hulbert), 219-227.
Mental Mistakes Which Cause Factual Accidents (Hulbert), 209-219.
Personality and Its Modifications: Habit Patterns, Adult Education, Its Techniques and Its Limitations (Hulbert), 236-241.
Peterson, C. A.: What Should an Anthracite Mine Safety Inspector Look For? 511-516.
Petroleum Industry: Accident Prevention Through the Eyes of an Insurance Executive (MacDonald), 620-622.
Cleaning Gasoline Storage Tanks Used for Leaded Gasoline (Lewis), 593-598.
The Effect of Legislative Trends on Safety (McLean), 610-614.
Enlisting Employees in the Accident Prevention Program. Panel Discussion, 600-610.
The Problem of Underground Service Station Tanks (Cadman), 614-620.
When and Where, and if so, What Fire Regulations are Needed for Producing Fields? (Prussing), 598-600.
Petroleum Section: Contest, 622-624. Minutes, 591-624. Officers, 591-592.

- Photographs: The Practical Application of Photography to Safety (Wagner), 277-278.
Physical Defects: Eye Examination Program, 66-67.
Physical Examinations: Follow-Up of Findings on Physical Examinations (Sander), 131-135.
Physical Examinations—Standard Requirements Expense (Garbutt), 405-407.
Pipe Lines: The Safe Disposal in Chemical Plants of Empty Containers Including Tanks, Drums, Cans, Bottles, Gas Cylinders, Dismantled Equipment, and Old Pipe Lines (Jones), 346.
Plant Transportation Session: 197-207.
Plays: Mr. Pro and Mr. Con Discuss Safety, 655-657.
Plzak, J. J.: Just What is the Safety Supervisor's Place in the Operating Organization? 259-260.
Pollock, Dr. L. J.: Traumatic Neurosis, 135-139.
Post, W. M.: Effectiveness of Grade Crossing Protective Devices from the Viewpoint of the Railroad Engineering Department, 702-707.
Posters: Safety Posters—Their Development and Use (Woodbury), 280-283.
Power Press Section: Minutes, 625-633. Officers, 625-627.
Power Press—Automotive and Machine Shop Sections: Joint Session, 313-318.
Power Presses: Accident Prevention Measures (Mould), 311-313.
Analysis of a Punch Press Accident. Panel Discussion, 103-105.
Preventing Power Press Accidents Through Periodic Machine Inspections (McDonald), 309-311.
The Safeguarding of Fast Punch Presses (Vollmer), 627-628.
Printing Industry: Health Hazards in the Printing Industry, 175-176.
Prizes: See Rewards.
Prussing, G. F.: When and Where, and if so, What Fire Regulations are Needed for Producing Fields? 598-600.
Psychology: See Personal Factors.
Psychology and Safety: Lectures (Hulbert), 209-243.
Public Buildings: What are the Common Causes of Accidents in Public Buildings and How Can They be Corrected? Panel Discussion, 49-62.
Why Should we Prevent Accidents in Public Buildings? (Morris), 47-49.
Public Employees: Water Utility (Adams), 644-646.
Public Safety: Cooperation with Public Officials. Panel Discussion, 193-196.
See also "After the Whistle Blows."
Public Utilities: Conserving Our Greatest Asset—Man Power (Mitchell), 18-26.
Lessons from Safety Experience (Shores), 643-644.
Mr. Pro and Mr. Con Discuss Safety, 655-657.
Public Utilities Section: Contest, 649-650. Minutes, 635-657. Officers, 635-637.
Publicity: Effect of World Unrest. Panel Discussion, 393.
Public Opinion (Frowns on Recklessness (Schl), 685-687.
Punch Presses: See Power Presses.
Purchasing: The Controlling Factor When Purchasing Safety Equipment. Panel Discussion, 454.

Q

- Quarry Industry: Analysis of Cement and Quarry Industry Accident Experience (LeGore), 323.
Quarry Section: See Cement and Quarry Section.

Index

- Quechel, E. G.: Safe Practices in Dairy and Ice Cream Plants, 665-666.
Questionnaires: Ask the Employee (Armstrong), 492-495.
"True or False?" Panel Discussion, 447-458.

R

- Railroads: How the Public and Authorities Can Aid in the Railroad Safety Program (Bales), 720-722.
How to Enlist the Support of School Children in Accident Prevention (Meyers), 717-718.
Inadequacy of Law Enforcement As a Solution to the Trespass Problem (Spitler), 715-717.
The Public's Responsibility in the Railroad Safety Problem (Gurley), 712-715.
The Railroads' Anti-Trespass Program (Maskell), 718-720.
Trespasser Accidents. Panel Discussion, 711-712.
See also Grade Crossings.
Refrigeration Industry: Hazards of Car Icing and Their Elimination (Ledbetter), 660-663.
Safe Practices in Ice Plants (Wright), 667-669.
Safe Practices in Refrigeration of Breweries (Kiernan), 663-665.
Refrigeration Section: Minutes, 659-669. Officers, 659-660.
Rentschler, P. E.: How to Build a Safety Program for the Small Foundry, 467-470.
Requarth, Dr. W.: The Maintenance of First Aid Units for Compressed Air Workers, 367-371.
Research: New Horizons of Science (Thomas), 303-304.
Resolutions, 26.
Responsibility: Management and Employee Responsibility in the Prevention of Personal Injuries (Miner), 338-341.
Management's Responsibility for Safety (Rohrer), 628-630.
The Placement of Accident Responsibility (Van-Cleef), 680-685.
Resuscitation: Pole Top Resuscitation Developments (Smith), 651-655.
Rewards: Drawing of Prizes or Sweepstakes, 556.
See also Contests.
Robinson, J. F.: Safe Handling of Bulk Materials, 554-557.
Rohrer, P. L.: Management's Responsibility for Safety, 628-630.
Rubber: The Use of Rubber and Rubber Compounds in the Chemical Industry (True), 328-333.
Rubber Industry: Dermatitis in the Rubber Industry (Obetz), 688-692.
Discussion of Dermatitis (Shirley), 692-696.
Rubber Section: Contest, 679-680. Minutes, 671-696. Officers, 671-672.
Rule Books: Safety Rule Books, 157-160.

S

- Safety Belts Session: 245-252.
Safety Directors: See Engineers; Supervisors.
Safety Stunts: Safety Stunts That Have Helped Maintain Good Housekeeping. Panel Discussion, 443.
Safety Supervisors Session: 253-260.
Safety Training Session: 261-276.
Dr. O. A.: Follow-Up of Findings on Physical Examinations, 131-135.
Discussion on Power Saws, 570.
Dr. R. R.: Pulmonary Diseases in the Mining Industry, 530-548.

- Schaefer, V. G.: Human Behavior and Safety, 313-318.
Schlossberg, V. E.: Electrical Hazards of Overhead Traveling Cranes, 199-203.
Schwarcman, Dr. A.: Eliminating Accident Hazards in Soybean Processing, 381-382.
Seagraves, C. M.: Work of the Illinois Agricultural Association in Farm Safety, 33-34.
Selz, L. H.: Public Opinion Frowns on Recklessness, 685-687.
Service Stations: The Problem of Underground Service Station Tanks (Cadman), 614-620.
Shepard, R. B.: Hazards and Proper Maintenance of Portable Electrical Equipment, 346-351.
Ship-building: Safety in Ship Design and Construction (Vickery), 412-416.
Shirley, Dr. J. N.: Discussion of Dermatitis, 692-696.
Shoes: See Clothing.
Shores, J. L.: Lessons from Safety Experience, 642-644.
Silicones: See Dusts.
Skin Affections: See Health Hazards.
Small Plants: How to Build A Safety Program for the Small Foundry (Rentschler), 467-470.
Maintaining Safety Interest in the Small Plant (Wilson), 463-466.
Smith, H. R.: Safety in Handling Live Stock, 428-431.
Smith, R. J.: Training Mechanics for Safe Air Transport Service, 299-300.
Smith, W. R.: Pole Top Resuscitation Developments, 651-655.
Solvents: Health Hazards in Spray Painting. Panel Discussion, 165-169.
The Toxic Limits of Common Solvents. Panel Discussion, 172-174, 176-177, 181-182.
Soutar, A. S.: Safety Belt Materials, 250-252.
Soybeans: Eliminating Accident Hazards in Soybean Processing (Schwarcman), 381-382.
Speed: What is Speeding? Panel Discussion, 395-396.
Spitler, W. L.: Inadequacy of Law Enforcement as a Solution to the Trespass Problem, 715-717.
Spontaneous Ignition: Spontaneous Ignition and Its Control (Brown), 82-86.
Sprains: The Control of Sprains and Strains (Wittmer), 121-125.
Spray Painting: See Paint.
Standards: Standardizing State Industrial Safety Requirements (Cameron), 115-117.
State Requirements: Standardizing State Industrial Safety Requirements (Cameron), 115-117.
Steam Railroad Section: Minutes, 697-722. Officers, 697-698.
Steel Industries: See Metal Industries.
Stilwell, Col. John: Annual Address, 11-14.
Stores: See Mercantile Establishments.
Storey, Capt. W. W.: How Safety Inspections Prevent Accidents, 416-417.
Strains: See Lifting.
Sturtevant, R. L.: A Competitive Safety Program that is Working, 726-728.
Suggestion Systems: Handling Suggestions, 161.
Supervisors: Getting Safety off the Defensive (Horrocks), 672-676.
Just What is the Safety Supervisor's Place in the Operating Organization? (Plzak), 259-260.
The Safety Supervisor's Part in the Investigation of Accidents (Zeilinger), 257-259.

T

- Tanks and Drums: Cleaning Gasoline Storage Tanks Used for Leaded Gasoline (Lewis), 593-598.
The Problem of Underground Service Station Tanks (Cadman), 614-620.

The Safe Disposal in Chemical Plants of Empty Containers, Including Tanks, Drums, Cans, Bottles, Gas Cylinders, Dismantled Equipment, and Old Pipe Lines (Jones), 341-346.
 Tanning Industry: Safety in the Meat Packing and Tanning Industries. Panel Discussion, 135-141.
 Tanning Section: See Meat Packing, Tanning and Leather Industries Section.
 Telephone and Telegraph: Lessons from Safety Experience (Corbitt), 647-649.
 Textile Industry: A Competitive Safety Program that is Working (Sturtevant), 726-728.
 Eliminating the Causes of Textile Accidents (Burger), 730-732.
 Methods of Developing a Competitive Safety Program (Monroe), 724-726.
 Safety Successes in the Textile Industry are Recognized (Hickok), 736-738.
 Textile Safety Through the Plant Nurse (Bethune), 728-730.
 Textile Section: Minutes, 723-738.
 Officers, 723-724.
 Thiele, C.: Specify the Safeguards, 307-309.
 Thomas, Dr. P.: New Horizons of Science, 303-304.
 Thrush, R. W.: Interest of American National Red Cross in Farm Safety, 37-39.
 Tools: Hazards and Proper Maintenance of Portable Electrical Equipment (Shepard), 346-351.
 Tower, W. S.: Accident Prevention in the Steel Industry, 458-461.
 Traffic: See Parking.
 Traumatic Neurosis (Pollock), 135-139.
 Tre-passing: See Railroads.
 Trucks: Hand: Industrial Hand Trucks Their Safe Construction and Use (Ziolkowski), 197-199.
 Safe Handling of Unit Materials (Long), 552-554, 556-557.
 Trucks: Power: Industrial Power Trucks Their Safe Use and Operation (Woollever), 203-207.
 Power Truck Operators. Panel Discussion, 442-443, 444.
 True, O. S.: The Use of Rubber and Rubber Compounds in the Chemical Industry, 328-333.
 "True or False" Questionnaire: 447-458.

U

U. S. Government: See Federal Departments.

V

Van Cleef, P.: The Placement of Accident Responsibility, 680-685.
 Vandevanter, E.: Safety Activities of the U. S. Army Engineers - Problems and Proposed Solutions, 400-402.
 Vickery, Com. H. L.: Safety in Ship Design and Construction, 412-416.
 Visual Education: The Use of Visual Aids in Accident Prevention (Lee), 278-280.
 Visual Education Session: 277-283.
 Vollmer, W. A.: The Safeguarding of Fast Punch Presses, 627-628.

W

Waesche, Rear Adm. R. R.: The Coast Guard Reserve A Safety Organization, 409-411.
 Wagner, C. L.: The Practical Application of Photography to Safety, 277-278.
 Wagons: Tail Lights for Wagons. Panel Discussion, 386-387.
 Walters, J. E.: Safety Features in the Construction of Hiwassee Dam, 372-374.
 War: See National Defense.
 Water Works: Water Utility (Adams), 644-646.
 Welding: Protection for Welders, 180-181.
 Whitney, O. J.: Proposals for Safe Regulation of Charter Operator, 292-294.
 Wilson, L. C.: Maintaining Safety Interest in the Small Plant, 463-466.
 Wittmer, Dr. J. J.: The Control of Sprains and Strains, 121-125.
 Wood Products Industry: Camp Facilities from a Safety Standpoint. Panel Discussion, 573-573.
 Discussion on Power Saws, 570.
 Facilities for First Aid in the Camp, in the Field and During Transportation. Panel Discussion, 573-574.
 Has the Mechanization of Woods Operation any Effect on Accident Experience? Panel Discussion, 576-577.
 Hazards Involved in Felling Operations, 578-579.
 Personal Protective Equipment Suitable for Men Handling Lumber. Panel Discussion, 740-741.
 Promoting Safety Consciousness Among Lumbering and Logging Operators. Panel Discussion, 574-576.
 Safe Methods of Loading and Unloading Logs, 580-581.
 Safety from Woods to Mill. Panel Discussion, 572-581.
 Safety in Lumber Remanufacturing Operations. Panel Discussion, 740-742.
 Safety Shoes for Wood Handlers, 580.
 Wood Products Section: Minutes, 739-742.
 Officers, 739-740.
 Wood Products - Paper and Pulp Sections: Joint Session, 569-581.
 Woodbury, E. L.: Safety Posters - Their Development and Use, 280-283.
 Woollever, C. E.: Industrial Power Trucks - Their Safe Use and Operation, 203-207.
 Wright, W. B.: Safe Practices in Ice Plants, 667-669.

Z

Zeilinger, A. H.: The Safety Supervisor's Part in the Investigation of Accidents, 257-259.
 Zimmer, V. A.: Safeguarding Manpower for Greater Production, 107-110.
 Ziolkowski, C. S.: Industrial Hand Trucks Their Safe Construction and Use, 197-199.
 Zorn, J. H.: Advantages That Have Been Gained Due to the Invention and Use of Motion Detectors, 527-530.

TRANSACTIONS

29th
NATIONAL SAFETY CONGRESS

STREET AND HIGHWAY TRAFFIC,
 COMMERCIAL VEHICLE, TRANSIT,
 CHILD EDUCATION AND HOME
 SAFETY SESSIONS

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this ventilating current be interrupted for a period of 24 hours and with the same amount of methane being liberated, there would be 5,760,000 cu. ft. of explosive mixture. Should this be contained in an entry 10 ft. square, the length of the entry would be approximately 11 miles.

Methane detectors are now available which will automatically indicate and record percentages of methane. One type may be located in working sections on cutting and loading machines, in the last breakthrough and along haulage roads. This can be adjusted to give a warning by a signal light or other means at any predetermined methane concentration. For example, at 1 per cent or any specified percentage between .5 per cent and 3 per cent, it will operate special electrical circuits through suitable relays to cut off the power in a section or

give warnings in other parts of the mine or to the outside. Methane recorders for continuously indicating and recording methane in main returns particularly have been perfected recently and are designed to be located in fan houses or other convenient places.

There is no relation between the volume of methane given off in a coal mine and the chemical composition of the coal, as both bituminous and anthracite mines produce methane, and methane has been found in metal and other mines when tunneling through carbonaceous shales. The common occurrence and explosibility of methane are responsible for numerous mine disasters and every precaution should be taken to keep it within safe limits. This can best be done by the use and guidance of methane detectors.

Pulmonary Diseases in the Mining Industry

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Although the attention of those interested in diseases peculiar to mining has been focused recently on one dust disease—silicosis—other respiratory diseases may cause more suffering and economic loss. The increased incidence of these diseases usually is attributed to exposure to abnormal air conditions underground, such as sudden changes from high to low temperatures, excessive dust, and noxious gases. The principal respiratory diseases to which the miner is subject are bronchitis, influenza and pneumonia, pulmonary tuberculosis, anthracosis, and silicosis. Although the mortality statistics in some of the tables included in this paper are old they have been corroborated by later, less complete data.

Bronchitis

Bronchitis is an inflammation of the bronchial tubes due, among other causes, to the inhalation of irritants such as dusts (organic and inorganic). Occupations that entail exposure to atmospheres polluted by irritating gases carry with them the risk of bronchitis. According to Collis,¹ it cannot be distinguished clinically from bronchitis occurring among the general population and its association with the inhalation of dust or gases usually is unrecognized.

During middle life bronchitis causes much recurrent invalidity and incapacity. Mortality records compiled by Collis² indicate that it is of a chronic traumatic origin associated with irritating atmospheric conditions, rather than of an infectious origin.

Statistics for bronchitis for the general population and for workers exposed to dusts in Great Britain³ for 1921-23 show the role played by dusts in the increased incidence of the disease in certain industries. The comparative mortality per thousand (ages 26 to 65) for those in occupations exposed to siliceous dust was 214, for those exposed to nonsiliceous dust 59.5, and for the general population 49.6. (See Table 1.)

In this connection it is interesting to note the mortality statistics per thousand (ages 26 to 65) for coal miners of counties of Wales (in which most of the coal mined is anthracite) compared with those for two other groups in England and Wales.⁴ The figures for coal miners are 112 for all underground workers and 139 for hewers and getters compared with 46 for males in the same social class and 50 for all occupied and retired males. (See Table 2.)

In a study by the United States Public Health Service⁵ 35 cases of chronic bron-

Table 1.—Mortality per 1,000 from Bronchitis in Dusty Occupations and in the General Population, by Age Groups

	Ages at Death					Comparative Mortality Figure
	20—	25—	35—	45—	55—	20- 65
Occupations exposed to						
Siliceous dust.....	1.1	1.0	13.7	44.6	153.7	214.0
Nonsiliceous dust.....			4.9	12.8	41.8	59.5
General population.....	0.5	1.7	5.4	13.3	28.8	49.6

chitis were found among 344 employees of two anthracite mining companies examined.

In the study conducted by the Bureau of Mines and the Public Health Service at Picher, Okla.,⁶ the highest incidence of silicosis or tuberculosis, or both, was found among men who reported having had bronchitis, pleurisy, and asthma.

Influenza and Pneumonia

Figures of mortality available for 4,700 miners insured in the group department of the Metropolitan Life Insurance Company⁷ show that in the last quarter of 1918 during the influenza epidemic 64 of these miners died of influenza or pneumonia. This is equivalent to an annual death rate of 50 per 1,000. Among all occupied males aged 15 years and over, the rate from influenza-pneumonia in the same 3 months was 22 per 1,000 or less than half as high. In the age period 45 to 65 years the rate among bituminous coal miners was about four times as high as among all occupied males in the same age group. (See Table 3.)

Influenza and pneumonia, as reported, were responsible, in the years under study, for 31 per cent of the mortality in the group of bituminous coal miners at ages 16 to 70 in Indiana, Missouri, and Wyoming compared with 19 per cent among both farmers and "all other males" at these ages in the same counties. (See Table 4.)

In 1918, the year of the great epidemic, influenza and pneumonia deaths constituted 55 per cent of total mortality exclusive of accidents among the bituminous miners in contrast with 27 per cent among the farmers and 34 per cent among all other males. These percentages were not as high as the figures for Wilkes-Barre. The fact that the soft-coal counties under consideration are largely rural areas may have made some difference.

In the epidemic year 1920, the proportion of deaths from influenza and pneumonia was smaller than in 1918, but, as was found for the anthracite miners, the bituminous group showed a wider difference in the pro-

Table 2.—Comparative Mortality Figures for Bronchitis per 1,000 of Certain Groups in England and Wales

	Bronchitis
Coal miners ¹	112
All underground workers.....	139
Hewers and getters.....	46
Males in same social class.....	50
All occupied and retired males....	302
Ratio of rate for hewers and getters to rate for same social class.	

¹ In three counties in Wales.

Table 3.—Influenza-Pneumonia Mortality among Bituminous Coal Miners—October to December 1918

Age Period	Annual Death Rate per 1,000	
	Bituminous Coal Miners	All Industrial White Males
All Ages ¹	50.1	22.3
15-25	29.5	17.5
25-45	62.1	32.6
45-65	44.4	11.7

¹ Fifteen years and over.

Table 4.—Percentage of Deaths from Influenza and Pneumonia (After Deducting Accidents) Among Bituminous Coal Miners Compared with Farmers, and With Other Males in the Same Areas of Several Soft-Coal Producing States¹

Male Groups Under Comparison	Ages					
	16-70	16-30	31-40	41-50	51-60	61-70
Bituminous coal miners.....	31.1	49.4	44.7	25.1	19.7	10.4
Farmers.....	18.7	38.4	32.4	19.7	12.4	10.8
All other males.....	18.6	30.0	29.0	16.0	11.3	10.8

¹ The death records for soft-coal miners were obtained from 15 coal-producing counties of Indiana, 1916-20, inclusive; 8 coal counties of Missouri, 1917-21, inclusive; and the 6 principal coal-producing counties of Wyoming, 1919-23, inclusive. The record for farmers and for "all other males" was obtained from the above-mentioned coal-mining counties, and also from 3 agricultural counties of Wyoming, 1919-23.

portion of deaths from this cause compared with "all other males" than in 1918. The percentages in 1920 were 29 for the soft-coal miners and 16 for "all other males." In this epidemic the bituminous miners at ages 40 to 60 suffered heavy excess mortality from influenza-pneumonia, but the differential mortality was not quite so great as at ages 16 to 30.

Among hewers and getters of soft coal in England and Wales, the death rate from influenza and pneumonia, 1921-23, was about 12 per cent greater than among males of comparable social status (social class 3). The difference was found to be 5.8 times the probable error of the difference which is certainly a significant variation. Thus, an abnormal mortality from influenza and pneumonia is consistently indicated among miners of coal both anthracite and bituminous in England as well as in America.

The pneumonia mortality figures in 1921-23 for occupations in Great Britain exposed to siliceous and nonsiliceous dust compared with those for the general population were given by Collis¹ as 134.3, 76.0, and 85.3, respectively; similar figures for influenza were 47.1, 49.6, and 36.5, respectively. (See Table 5.)

According to Brundage,⁴ an outstanding feature of the statistics of death for hard-coal miners in the United States is their extraordinary mortality from influenza and pneumonia not only during influenza epidemics but at other times as well. In a study by the Public Health Service at Wilkes-Barre, Pa., in 1915-23 and 1906-25⁴ it was found that influenza and pneumonia were responsible for 40 per cent of the total deaths compared with 25 per cent among males at ages 15 to 65 who had been en-

gaged in pursuits other than coal mining in Wilkes-Barre and vicinity. The percentage of deaths from influenza and pneumonia for these two groups by ages for the years mentioned was 19.3 for anthracite miners compared with 13.3 for males in other industries. (See Table 6.)

Tuberculosis

In 1925 Collis⁵ said that for coal miners generally the tuberculosis rate apparently is low although miners at the coal face suffer from the disease more than other coal miners underground and workers above ground. Results of more recent investigations seem to contradict the assumption that tuberculosis does not occur among coal miners. An investigation by the Welsh School of Medicine, reported in 1937,⁶ indicates that this supposed exemption of coal miners from tuberculosis may be due to a mis- or partial diagnosis. This investigation revealed a high incidence of tuberculosis (35 per cent if the "probable" cases are included) among the pneumoconiotics of the South Wales coal fields and supports the theory that coal dust modifies the tuberculosis, leading to failure to recognize the disease or to the mistaken diagnosis of "bronchitis."

Studies by the United States Public Health Service⁷ revealed that 6 per cent of hard-coal miners examined had clinical pulmonary tuberculosis. The average prevalence in the adult male population of the United States is about 2 per cent. The prevalence of pulmonary tuberculosis among hard-coal mining employees at ages below 35 was slightly less than that found through studies among male adults in the general population. In the age group 35 to 44, however, the prevalence of tuberculosis was

Table 5.—Mortality per 1,000 from Pneumonia and Influenza in Dusty Occupations and in the General Population

	Pneumonia					Comparative Mortality Figure
	Ages at Death					
	20-	25-	35-	45-	55-	
Occupations exposed to Siliceous dust.....	3.3	14.4	30.6	47.2	38.7	134.3
Nonsiliceous dust.....		9.6	13.7	28.7	23.9	76.0
General population.....	4.3	11.5	19.6	24.2	25.7	85.3

	Influenza					
	20-	25-	35-	45-	55-	
Occupations exposed to Siliceous dust.....	1.1	7.7	11.3	8.7	18.3	47.1
Nonsiliceous dust.....	5.4	4.8	13.7	10.6	14.9	49.6
General population.....	2.0	5.2	7.7	9.7	12.0	36.5

about twice, at ages 45 to 54 about 5 times, and for ages above 55 it was about 10 times the rate found in the general population. The highest prevalence of clinical pulmonary tuberculosis occurred among the rock workers (men who had been employed in rock loading or rock extraction for more than 2 or 3 years). After 20 years' service, of which more than 2 or 3 years were in rock work, 37 per cent presented evidence of pulmonary tuberculosis. In a group of 135 completely disabled former anthracite workers, which did not include any known cases of tuberculosis, 10 per cent proved positive for pulmonary tuberculosis. These findings would appear to corroborate those of the Welsh National School of Medicine that indicate that the supposed exemption from tuberculosis of coal miners is erroneous due to incorrect diagnosis. There is evidence that the above increased incidence of tu-

berculosis is associated with exposure to silica dust.

The incidence of tuberculosis is much higher in metal mines than in coal mines, due no doubt to exposure to dust containing a higher concentration of silica. An investigation in 1914 by the Bureau of Mines in cooperation with the Public Health Service of pulmonary disease among the zinc miners of the Joplin, Mo., district, revealed a high death rate from pulmonary tuberculosis. The mortality rate for tuberculosis for Jasper County was 200.8 per 100,000 for 1911 and 1912 and 229.7 for 1913, according to statistics of the State Board of Health.⁸ On the other hand, according to the Jasper County Antituberculosis Society, during the calendar year 1912 there were 720 deaths among miners who had worked 2 years or more underground in Jasper County. Not all

Table 6.—Percentage of Deaths from Influenza and Pneumonia among Anthracite Miners and among Males in Occupations Other Than Mining in Wilkes-Barre and Vicinity

Groups Under Comparison	Ages					
	15-64	15-24	25-34	35-44	45-54	55-64
Anthracite miners.....	39.8	45.2	67.9	42.9	31.8	19.3
Males in other industries.....	25.3	28.7	46.2	31.0	16.8	13.3

Table 7.—Mortality per 1,000 from Pulmonary Tuberculosis in Dusty Occupations and in the General Population

	20	Ages at Death				
		25-	35-	45-	55-	20-65
Occupations exposed to						
Siliceous dust	25.6	63.4	141.0	211.6	150.6	592.2
Nonsiliceous dust	13.6	26.3	46.1	56.4	29.9	172.4
General population	20.6	37.6	43.6	39.0	22.7	163.5

of these 720 deaths occurred in that county but they had contracted the disease there and some of them had moved away. Of 93 miners in the Joplin District examined by Lanza in 1914,¹⁰ 64 showed definite symptoms of pulmonary disease and 39 of the 64 had the classical symptoms of pulmonary tuberculosis.

In a study by the Bureau of Mines and the Public Health Service¹¹ in Butte, Mont., during 1916 to 1920 the death records of the State Board of Health were examined. These showed that during 1915, 122, during 1916, 126, and during 1917, 169 Butte miners died of tuberculosis. The significance of the death from tuberculosis of 169 miners in 1917 is indicated by comparison with the records of other regions. In 1917 approximately 14,000 men were employed underground in Butte mines; with 169 deaths from tuberculosis for the year, the rate per 100,000 was 1,207. The tuberculosis death rate of Michigan for the 10-year period 1910 to 1920 was 97.4 per 100,000; hence the tuberculosis death rate of Butte miners was nearly 13 times as great as that of Michigan.

The part played by dust, especially dust containing silica, in the production of pulmonary tuberculosis is shown clearly by figures for Great Britain for 1921-23.¹² The death rate per 1,000 for ages 20 to 65 was 592.2 for those exposed to siliceous dust, 172.4 for those exposed to nonsiliceous dust, and 163.5 for the general population; for ages 35 to 44 the figures were 141.0, 46.1, and 43.6, respectively; for ages 45-54 the figures were 211.6, 56.4, and 39.0, respectively; and for ages 55 and over the figures were 150.6, 29.9, and 22.7, respectively. (See Table 7.)

According to Collin¹ the prevalence of bronchitis, pneumonia, and tuberculosis is

high among those exposed to silica dust but the incidence of these diseases is not always the same under other conditions such as exposure to other dusts, heat and fumes, or working indoors. (See Table 8.)

Anthracosilicosis

From 1931 to 1937, 87 per cent of the total deaths in Great Britain due to silicosis occurred among the coal miners of South Wales; two-thirds of the deaths and disease occurred in the Swansea Division; and 89 per cent of the medical certificates granted in the Swansea Division related to anthracite collieries.¹³

In the United States the chronic disease among miners due to breathing air containing dust generated in the various processes involved in the mining and preparation of anthracite is called anthracosilicosis. This is a descriptive title for the form of pneumoconiosis commonly called miners' asthma. The disease was found in about 23 per cent of 2,711 employees of three anthracite mining companies studied by the United States Public Health Service in 1933. About 63 per cent of those having anthracosilicosis showed evidence of disability, compared with less than 10 per cent in the control group. Moderate and marked degrees of disability handicapped approximately 21 per cent of those with anthracosilicosis compared with less than 2 per cent of the men serving as controls.

Wide differences were found in the extent of physical impairment in the several occupational groups. The highest rate of disability from all causes combined was found in the group of men that had changed more than 5 years before the date of examination from very dusty to relatively nondusty occupations in the industry. In a

Table 8.—Prevalence of Bronchitis, Pneumonia and Tuberculosis Under Certain Conditions of Exposure

Exposure	Bronchitis	Pneumonia	Tuberculosis
Outdoor and indoor life	low	low	low
Indoor industries	low	low	high
Coal trade	high	high	low
Alcohol trade	moderate	high	high
Heat and fumes	high	high	low
Dust of			
1. Animal origin	low	low	low
2. Vegetable husks and debris, certain inorganic materials	high	medium	low
3. Silica	high	high	high

number of instances the change in occupation probably was made on account of physical condition. Miners at the coal face, rock workers, and men who had had appreciable exposure to harmful dusts in other industries also showed evidence of much greater physical impairment than was found in the control group.

Moderate or marked physical impairment from any cause was found in 1.7 per cent of the control group, in 9.9 per cent of the regular miners, and among 12.6 per cent of the rock workers.

There was a marked tendency toward increase in the proportion having physical impairments with increase in the number of years of employment in anthracite. This tendency is manifested whether one considers disability of any kind, disability in which pulmonary infection was contributory, or disability due largely to tuberculosis. In each case the occupational groups arrayed themselves according to extent of physical impairment as follows: (1) Rock workers; (2) regular miners; (3) all others exposed to more than 100 million dust particles per cubic foot of air; and (4) men in haulage-ways except rock workers.

The pathology of anthracosilicosis as observed in these cases is essentially a deposition of coal dust in the lungs, accompanied by an extensive fibrosis, both diffuse and nodular, with associated functional and degenerative changes, (silicosis modified by coal dust).

That excess mortality from respiratory diseases as a whole is experienced by American hard-coal miners is clear from the studies made by the Public Health Service.¹⁴

The anthracite miners' proportionate mortality from all respiratory diseases was about 1½ times that of the other adult males in the same region. When proportionate mortality was computed for ages 16 to 65 in Wales,¹⁵ it was found that respiratory diseases accounted for 53 per cent of the deaths of anthracite miners compared with 38.2 per cent among males in the same social class. The proportion among hewers and getters of anthracite therefore was 1.4 times that of men of the same social status.

Silicosis

There are various definitions of silicosis but all agree that the cause of the disease is the inhalation of silica or quartz dust.¹⁶ Silicosis is a well-recognized clinical and pathological entity at least as characteristic as that of any cause of death known to epidemiologists.¹⁷ The definition of silicosis, adopted at the International Silicosis Conference in 1930 and reaffirmed at the 1939 Conference and generally accepted is:

"Silicosis is a pathological condition of the lungs due to inhalation of silicon dioxide. It can be produced experimentally in animals."

The first investigation of silicosis in the mining industry in the United States was made in 1914-15 by the Federal Bureau of Mines in cooperation with the United States Public Health Service in the Joplin (Mo.) mining district.¹⁸ As only a few men were examined at that time, it was decided to examine a larger number to gain a more accurate idea of the prevalence of consumption among the miners of this district. From

Table 9.—Mortality from Certain Respiratory Diseases of Those Exposed to Siliceous Dust, to Nonsiliceous Dust, and the General Population—by Age Groups¹

Groups	Respiratory Diseases											
	Bronchitis				Influenza				Pneumonia			
	20-25	25-35	35-45	45-55	20-25	25-35	35-45	45-55	20-25	25-35	35-45	45-55
Siliceous dust	1.1	1.0	13.7	44.6	153.7	214.0	1.1	7.7	11.3	8.7	18.3	47.1
Nonsiliceous dust	4.9	12.8	41.8	59.5	5.4	4.8	13.7	10.6	14.9	49.6	9.6	13.7
General population	0.5	1.7	5.4	13.3	28.8	49.6	2.0	5.2	7.7	9.7	12.0	36.5

¹ Made up from tables 1, 5 and 7.

May 15 to December 31, 1915, 720 miners were examined: 45.7 per cent had silicosis and tuberculosis and 5.3 per cent had tuberculosis.¹⁰ A later report (1917) of this same investigation by Lanza and Childs¹¹ included the results of the first detailed X-ray studies of silicosis made in the United States.

Investigations of mining conditions by Harrington and Lanza¹² in Butte, Mont., in 1921, revealed that 42.4 per cent of 1,018 miners examined showed definite signs of lung damage due to dust.

From July 1, 1927, to June 30, 1932, the Metropolitan Life Insurance Co., the Tri-State Zinc & Lead Ore Producers Association, and the Federal Bureau of Mines operated a cooperative clinic at Picher, Okla.,¹³ to demonstrate to industry a workable method for diagnosis of silicosis, to educate workers in preventive measures, and to serve as a model to industries presenting a dust hazard. Of 27,553 individuals examined during this period 5,366 had silicosis, 742 silicosis plus tuberculosis, and 320 uncomplicated tuberculosis.

The chief cause of disability in silicosis is tubercle infection. The silicotic lung appears to be a more favorable medium for the growth of the tubercle bacillus than the normal lung, not because it is fibrotic, nor because its lymphatic drainage is interfered with, but because it contains silica.¹⁴ Apparently silica dust possesses this characteristic of increasing the liability to pulmonary tuberculosis. That this is true is indicated by the statistics quoted in this paper which indicate also that silica dust increases the liability to other respiratory diseases. (See Table 9.)

The results of virtually all studies are in agreement regarding the high mortality rates from tuberculosis for industries in which large numbers of men are exposed to a silica hazard. These rates are so high that they leave no room for doubt of the cause-and-effect relationship between the hazard and the high mortality.¹⁵

Joint studies made by the Actuarial Society of America and the Association of Life Insurance Medical Directors¹⁶ revealed that there were 65 deaths where 6 were expected (about 11 times the expected number) from tuberculosis in 1925-1936 among a group of underground miners, most of

whom were employed in metal mines. Tuberculosis deaths were fourteen times the expected among copper miners, nine times the expected among gold and silver miners, and eight and a half times the expected among iron miners. In an earlier study¹⁷ covering the years 1915-1926, there were 18 times as many deaths as expected among lead and zinc miners.

An analysis by the field division of the Saranac Laboratory¹⁸ of the roentgenograms of 5,000 white miners exposed to the inhalation of harmful concentration of silica dust shows that the incidence of pulmonary tuberculosis lesions increases as the degree of reaction to dust progresses. In this group of miners tuberculous lesions were found in approximately one-fourth of those with first stage silicosis, one-half of those in the second stage, and 65 per cent of those in the third stage.¹⁹

Prevention of Dust Diseases in Mining

The data given in this paper point to dust as the greatest contributor to the excessive mortality from pulmonary diseases experienced in the mining industry and to silica dust as the immediate cause of the disease silicosis. Therefore, the principal method of preventing these diseases is to eliminate as far as possible or reduce to harmless concentration the dust in the breathing zone of the workers. Experience has shown that the properties of a dust that determine its capacity to produce injurious effects are its composition, the quantity suspended in the atmosphere breathed by the worker, and its particle size.

Although any dust may be harmful to breath under certain conditions, as indicated by the data presented here that show a higher incidence of pulmonary diseases in nonsiliceous dusty industries than in the general population, physiological studies reveal that, in mining the harmfulness of a dust is proportional to its content of free silica or quartz, in particles small enough to enter the finer spaces of the lungs, and in high enough concentration to overcome the normal defenses of the respiratory system.

The prevention of dust diseases is the function of the physician and the engineer, working together to determine the extent of the dust hazard in industry and methods for its control.

The first step is to determine what dusts are harmful and in what concentrations. The procedure is somewhat as follows: It is observed that respiratory diseases appear more frequently or with greater severity among workers in certain industries or in connection with certain operations within an industry. The physician attempts to determine the extent of the injury to the health of those exposed and the cause. If the cause appears to be exposure to excessive dust, the engineer samples the air to determine the kind, amount, and size of the dust present. The physician and the engineer can correlate the results of their investigations to determine allowable concentrations of dust, exposure to which is not likely to cause harmful physiological reactions. The engineer is then in a position to devise measures for the reduction of the dust to a harmless concentration. The aim, of course, should be to eliminate the dust entirely or to reduce the dust to a concentration that will not cause disability during the working lifetime.

Allowable Concentrations of Dust in Mining

Investigations conducted over a period of years show that exposure to certain concentrations of harmful dusts for a certain time causes varying degrees of respiratory disability but that below these concentrations disabling pulmonary diseases do not occur within a working lifetime. The classical example of this is the experience in South Africa with the reduction in mortality from silicosis that has followed the reduction in air dustiness in the mines of that country.

The reduction in the incidence of silicosis in the South African mines attests the effectiveness of the control measures employed and the practicability of using a definite dust concentration as a guide in setting allowable limits of air dustiness in the prevention of pneumoconiosis in dusty industries. The production rate of silicosis in the scheduled mines of South Africa²⁰ in 1932-35 was 9.59 per 1,000 compared with 21.95 in 1917-18. (See Table 10.)

The incidence rates for silicosis uncomplicated by active tuberculosis among South African miners in 1936-1937 was between 8 and 9 per 1,000 per annum.²¹ The liability among the whole body of miners to contract the disease in 1936-37 was less by 65

Table 10.—Average Number of Miners Examined Annually and Production Rates for Silicosis in Each Triennial Period Since 1917-18

Period	Average Number of Miners Examined Annually	Production Rate of Silicosis per 1,000	Period	Average Number of Miners Examined Annually	Production Rate of Silicosis per 1,000
1917-20	14,070	21.95	1926-29	14,624	21.11
1920-23	13,260	19.16	1929-32	16,774	13.87
1923-26	12,523	33.28	1932-35	20,139	9.59

per cent than it was in 1920-23. Among the "new Rand miners" who entered the industry by way of initial examination since 1916 and who have been exposed solely to the progressively improving occupation conditions that have obtained since that date, the liability to contract silicosis was less by 87 per cent than the similar liability among all miners working for an equal period in 1920-23. These "new Rand miners" constituted 77 per cent of all working miners examined. The group of pre-1916 miners, who in 1935-36 constituted less than 17 per cent of the total number of working miners contributed nearly 78 per cent of the new cases of silicosis.

In the study by the Public Health Service* of anthracosilicosis among hard coal miners silicosis was not found in a control group of mining employees whose dust exposure averaged less than 5 million particles per cubic foot of air.

The prevalence of anthracosilicosis among the entire group of employees was found to be about 23 per cent.

Among all except rock workers, less than 2 per cent of the men developed anthracosilicosis when the duration of employment was less than 15 years, regardless of the amount of dust in the air.

Among men exposed 15 to 24 years to dust containing less than 5 per cent free silica, 14 per cent of those who had worked where the average dust content was 100 to 199 million particles per cubic foot, 29 per cent of those exposed to 200 to 299 million particles, and 58 per cent of the men who had worked for this period in more than 300 million particles per cubic foot, developed anthracosilicosis.

Among men employed for more than 25 years in dust containing less than 5 per cent free silica, the proportion of persons found with anthracosilicosis under different concentrations of dust was as follows: 5 to 99 million particles, 7 per cent; 100 to 199 million particles, 54 per cent; 200 to 299 million particles, 71 per cent; 300 or more million particles per cubic foot, 89 per cent.

With the exception of miners, their helpers, and rock workers, about 25 per cent of all the men employed underground developed anthracosilicosis after a working period of more than 25 years. This group was exposed to dust having a quartz content of about 13 per cent.

The prevalence of anthracosilicosis among persons who had been exposed for more than 2 or 3 years to dust of which about 35 per cent was free silica, varied from 10 per cent among those who had worked in concentrations of less than 200 million particles per cubic foot for less than 15 years, to 92 per cent among those who had been employed for more than 25 years in dust concentrations exceeding 300 million particles per cubic foot, more than 2 or 3 years of which time was spent in rock work.

Age per se appeared to play a minor role in the development of anthracosilicosis.

Analysis of the data for the purpose of determining safe limits of dust exposure indicated that employment in an atmosphere containing less than 50 million dust particles per cubic foot would produce a negligible number of cases of anthracosilicosis when the quartz content of the dust was less than 5 per cent. In the gangways where the silica content of the dust was about 13 per cent, a safe limit appeared to be 10 to 15 million

Table 11.—Pneumoconiosis Cases Occurring Among 798 Workers Exposed to Mixed Dust, Classified by Average Dust Concentration, Length of Employment, and Number of Workers Exposed

Average Dust Concentration (Million Particles per Cubic Foot)	Years in Industry				
	0-4.9	5-9.9	10-14.9	15-19.9	20 and Over
0-9:					
Number of pneumoconiosis cases.....	0	0	0	0	0
Number of workers exposed.....	81	56	29	13	8
Percent with pneumoconiosis.....	0%	0%	0%	0%	0%
10-24:					
Number of pneumoconiosis cases.....	0	0	0	2	4
Number of workers exposed.....	123	94	66	29	23
Percent with pneumoconiosis.....	0%	0%	0%	6.9%	17.4%
25-49:					
Number of pneumoconiosis cases.....	0	0	3	3	6
Number of workers exposed.....	43	45	31	11	18
Percent with pneumoconiosis.....	0%	0%	9.7%	27.3%	33.3%
50 and over:					
Number of pneumoconiosis cases.....	0	4	5	4	4
Number of workers exposed.....	45	44	25	8	6
Percent with pneumoconiosis.....	0%	9.1%	20.0%	50.0%	66.7%

particles per cubic foot. The limit of toleration for rock workers was set tentatively at 5 to 10 million particles per cubic foot of air. Similar results were obtained by the Public Health Service in an investigation of pneumoconiosis among mica and permatite workers. (See Table 11.)

The relation of the average dust concentration and duration of exposure to the percentage of workers found to have pneumoconiosis was as follows: Of those who had worked in an average concentration of 50 million particles of dust per cubic foot of air, 9 per cent had pneumoconiosis in 5 years, 20 per cent in 10 years, 50 per cent in 15 years, and 66 per cent in 20 years. Of those who worked in an average concentration of 25 million particles 10 per cent had pneumoconiosis in 10 years, 27 per cent in 15 years, and 33 per cent in 20 years. Of those who had worked in an average concentration of 10 million particles of dust, 7 per cent had pneumoconiosis in 15 years and 17 per cent in 20 years. (See Fig. 1.)

The data obtained in other studies of dusty trades, anthracite mining, asbestos textile manufacture, and the pottery industry have been treated in a similar fashion and have yielded similar, although usually less regular, results. The position of the threshold

value below which no cases were found and the magnitude of the trends between per cent affected and both time and intensity of exposure varies in different sets of data, depending, to a large extent, on the chemical nature of the dust to which workers were exposed and possibly on the regularity of employment.

It is tempting to seek to summarize the data of table 12 and figure 1 into a simple mathematical relation such as the following: With each twofold increase in average dust concentration above 10 million particles per cubic foot, the probability of finding cases of silicosis (in men exposed for comparable lengths of time) is approximately doubled. Application of the standard methods of curve fitting would yield more refined descriptions of these data. Nevertheless, it does not seem to be advisable to set up any mathematical treatment because, of all the men who entered the industry, only the survivors have been studied. There is no adequate way of finding out whether or not men who dropped out of the industry were in a better or worse state of health as far as silicosis is concerned than men who remained in the industry, and thus there is no way of introducing a correction for this element of selection into a mathematical

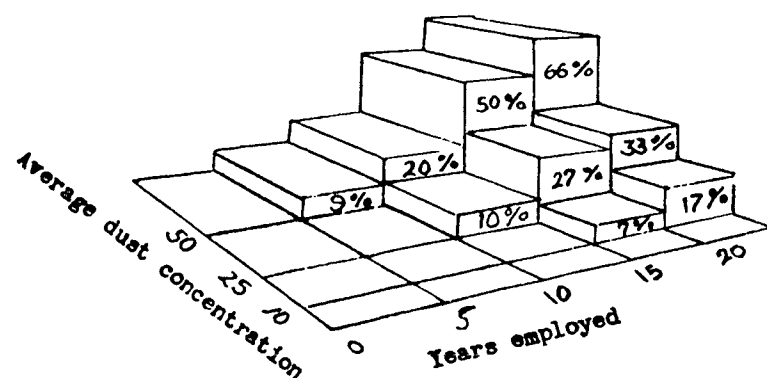


Figure 1.—Relation of average dust concentration and duration of dust exposure to the percentage of workers found to have pneumoconiosis. Based on data presented in Table 11.

treatment. It seems to be preferable to present the facts as simply as possible, together with the precautions to be kept in mind in studying them, and to emphasize that the principal use of these data is to show the degree of improvement in health to be expected in the future if dust formation and dust dispersal are brought under control in these and in similar industries.

Methods of Dust Control

After the physician and engineer have learned by observation and experimentation what kinds of dust are harmful and in what concentrations, it is the function of the engineer to evaluate the hazard in a particular industry, plant, or mine and devise measures for its elimination. The first step is to become thoroughly familiar with the industry being studied to determine the dusty occupations, the number of persons in each, and the various activities and time devoted to each activity in any one occupation.²⁴

The amount of harmful dust created by various activities can be determined by taking samples of the atmosphere in their vicinity and counting and identifying the dust particles. Sampling of air is also a means of checking the efficiency of any control measures that may be adopted.

Several devices are available for collecting and counting dust samples. The im-

pinger, however, is the instrument used most frequently in the United States. The Bureau of Mines and the Public Health Service have issued publications describing the method of sampling dust by the impinger (as well as by other methods) and procedures for counting and identifying the particles.²⁵

Dust sampling is complicated by the fact that air dustiness fluctuates rapidly from moment to moment. A single dust count represents only the amount of dust in the atmosphere at the time and place of sampling and gives no indication of the average exposure of the worker over a period of years, especially if he has not worked continuously at one job. The ultimate lung injury that he may suffer will depend upon the integrated effect of the dust over a long period.²⁶ A proper measure of dust exposure requires a picture of the variations in dustiness. The best procedure is to determine the dustiness during different stages of an operation and, with the aid of a time study, break down the worker's day according to the time spent in each step; from these data the average dust exposure of the worker can be calculated.

Drilling.—Experience in South Africa²⁷ with new methods of sampling have revealed that more dust is produced by rock drills

Table 12.—Period Worked at Face by First-Stage Silicotics

Job	Average Number of Years	Number of Men	Job	Average Number of Years	Number of Men
Shovelers' helpers (bruno men).....	6.8	8	Machinemen (drillers).....	11.4	348
Shovelers.....	8.4	428	Powdermen.....	11.5	24
Drillers' helpers (dummies).....	8.4	70	Shovel bosses.....	15.8	21
Trackmen.....	9.8	52	Ground bosses.....	19.0	54
Roof trimmers.....	11.3	26			

than had been suspected, the difference consisting entirely of dust too fine to be detected by the older methods. The importance of control of drilling dust as a measure of the prevention of silicosis is demonstrated by the fact that the incidence of silicosis has remained consistently and considerably higher among machine drillers than among those who have never worked machines, and the excess incidence among machine drillers has been in direct proportion to the amount of time spent upon rock drilling.

Until relatively recently drilling of holes for blasting was a negligible producer of dust or air dustiness in coal mines especially other than anthracite mines. The hand-operated auger drill produces very little fine dust, but with the extension of mechanized mining power drills are becoming more and more essential and some of them are heavy producers of finely divided dust; this is especially true of reciprocating drills of the jackhammer type drilling dry and using compressed air in the clearing of holes either in coal or in roof or floor material.

Blasting.—The exceptionally heavy incidence of silicosis among rock drill miners in the early period of the gold-mining industry in South Africa²⁸ was due to the exposure of the rock-drill miner not only to drilling dust but to high concentrations of dust from blasting, and frequently to the inhalation of varying amounts of the irritant fumes produced by blasting, owing to the methods of blasting then in use. Blasting produces large quantities of very fine dust, the finest fractions of which tend to remain suspended in the mine air for a long time, unless removed by ventilation.

Shoveling or Mucking.—In the Picher, Okla., study,²⁹ it was difficult to show the relationship of the duties of the men to

silicosis because of frequent change of occupation. All examined were divided into two groups—those exposed to large amounts of dust (those employed at the face) and those exposed to relatively small amounts (those away from the face). In the order of exposure to the dust hazard, the men at the face included shovelers' helpers, shovelers, drill helpers, machinemen, trackmen, roof trimmers, powdermen, shovel bosses, and ground bosses. According to analysis of the occupations of face workers the hazard was greater for shovelers' helpers and shovelers than for machinemen if length of time required to produce first-stage silicosis is a criterion. It is noted from table 13 that the average number of years worked by shovelers' helpers and shovelers was 6.8 and 8.4 years, respectively, while that for machinemen was 11.4 years.

Loading and Hauling.—Under some conditions hand loading of coal throws into the air of the working place considerable quantities of dust, but the amount is about one-tenth that caused by some types of mechanical loading. The greatly increased occurrence of dust from mechanical loading is due not only to the stirring of the dust into the air by the loading machines themselves but also to the greater rapidity of breaking down and taking coal from the face regions which increases other dust producing processes, especially blasting, cutting, and hauling.³⁰

Poorly constructed or poorly maintained pit cars or over-topping of coal in cars allows fall off or fine material to sift through to the tracks to be ground under the wheels of rolling equipment or the hoofs of mules and then to be thrown into the air by speeding cars or shuffling mules or men.³¹

Where conveyors (either the shaker or belt type) are used they form potential sources of dust clouds at the points where the coal is dropped or thrown which occurs at the discharge ends only. Also, where conveyors are used conditions at the face differ from those experienced with the older methods of working in that the miners are closer together, there is a tendency with the more systematic working for a larger number of the men to perform dust-raising operations at the same time, and the air speed at the faces is higher.²⁰ These conditions, if not controlled, tend to increase the dust exposure to the face workers.

Machine coal cutting.—When coal-cutting machines came into the picture early in the present century to supersede in large part both hand cutting and blasting off the solid, the really heavy producer of coal dust that the worker has had to endure was at hand, and this was especially true of the chain machines operated by electricity. Top cutting is the worst offender in so far as impregnating the air with dust is concerned, shearing occupies an intermediate position, and undercutting is the least offensive in this respect. However, undercutting machines under some conditions (such as cutting dry in friable coal with dull bite in a confined place with little or no circulating air) may produce air dustiness so dense as to reduce visibility almost to zero with available types of mine lighting and to cause between 100,000,000 and 500,000,000 (or even more) dust particles to be carried per cubic foot of air of the face region.²¹

Methods of Control

The principal measures for controlling dust in mining operations are ventilation, wet methods, proper blasting practice, the use of personal respiratory protection, and physical examination.

Ventilation.—The more or less generally accepted conclusion that coal miners suffer less from miners' consumption than metal miners, who either die early in life or are incapacitated in middle age, is due almost entirely to the superior working conditions in coal mines as a result chiefly of ventilation.

Approximately in order of their importance, the main features that affect air in metal mines are (1) movement, (2) temperature, (3) relative humidity, (4) gases, and

(5) dusts. In coal mines the order of importance would probably be (1) movement, (2) gases, (3) dusts, (4) relative humidity, and (5) temperature.²²

The matter of movement of air from the surface, through the working faces or places, and then back to the surface is by all means the most important consideration in effecting adequate ventilation of mines and in protecting the health and forwarding and maintaining the working efficiency of the underground workers. If adequate quantities of pure air are directed to the places where men work, most of the requirements of health and many of the demands of safety will be well served.²³

Ventilation probably is the most effective dust-control measure although under some conditions it ranks second to wet methods. Where ventilation can be applied effectively, dust can be removed from the air or its concentration can be so diluted as to render it almost harmless.²⁴

Wet methods.—As dry drilling is the dustiest operation in mining, wet drilling will keep air dustiness within safe limits if used with care and judgment in collaring wet, using plenty of clean, dirt-free water, and keeping the drills in good repair with adequate regulation of the proportion of water and compressed air flowing through the drill steel.²⁵

In tests by the Bureau of Mines²⁶ the dust concentration in the air during actual drilling decreased as the water flow through the drill increased. The water flows for stopers was 0 to 3 gallons per minute, and that for drifters from 0 to 1.02 gallons per minute. The rate of decrease for stoper drills was greater for water flows from 0 to 1.3 gallons per minute than for higher water flows. The rate of decrease for drifter drills was similar to that for stoper drills at corresponding water flows and rather constant for water flows of 0 to 1.02 gallons per minute.

The results of this study shows that as water flow through the drills was increased the dust concentrations in the air decreased, but they do not show whether the decrease was caused directly by the increased water flow, by some condition influenced by variation in water flow, or by a combination of these factors.

In most pneumatic rock drills air passes

through the drill steel with the water. Ordinarily some of the high-pressure air supplied to the drill for its operation escapes into the back end of the drill steel, even when the operating throttle is not in the blowing position, and travels up to the face of the hole being drilled. The amount of air escaping is affected by the water flow through the drill steel; as the water flow through the drill steel increases the air flow decreases. Mining officials in South Africa concluded that such air leakage, although probably facilitating removal by the water of the cuttings from the hole, was responsible for entrapping fine dust and blowing it into the air during drilling.²⁷ Consequently they have devoted much attention to designing drills that permit the minimum practical air leakage through the drill steel and have established regulations on the use of such drills. Canada is also doing much work along this line, and recent reports state that such drills are practical and produce about one-fourth the dust concentration of corresponding drills without the "dustless-head" features.²⁸

The results of this study show that operators can reduce dust concentrations resulting from drilling by increasing the water flow through the drill steel, either by increasing water pressure or by the use of water tubes of larger inside diameter.

Tests also have been conducted by the Bureau of Mines²⁹ on the effectiveness of spraying water along the outside of the drill steel compared with that of standard wet-drilling practice. The tests show that spraying water along the outside of the drill steel should not take the place of regular wet drilling. However, if a method is developed by which the device may be used on holes of any inclination, it might prove to be a valuable accessory to regular wet drilling in collaring and drilling the first 2 feet of a hole. Tests show that the greatest amount of dust is thrown into the air of a working place in drilling the first 2 feet of a hole.³⁰

Wet drilling standards have been adopted in New York State for drilling in various classes of rock. The requirements for drilling in Class II rock (rock containing more than 10 per cent free silica) in confined areas, which include the use of mechanical ventilation, are quoted below.³¹

1. "Wet drilling shall mean the continuous application of water through the central

hole in the hollow drill steel to the bottom of the drill hole. The central hole in the steel shall not be less than $\frac{1}{8}$ " diameter.

2. "The water flow shall be maintained continuously whenever the drill is in operation, including the period of collaring or starting the drill hole. The valve in the water line shall be of such design that it has only two fixed positions, namely, closed and completely open. Six months after date of approval, all wet drills shall be equipped with a combination air throttle and water valve of such design that the required rate of water flow through the drill steel will be insured whenever the air throttle is in the operating positions, half speed as well as full speed.

3. "The water shall be clean and bacteria free and shall be delivered to the drills under pressure from an adequate source of supply. Portable water tanks for individual drills shall not be used unless approved by the Industrial Commissioner.

"Wet drilling in Class II rock in confined areas shall be used with mechanical ventilation, or in confined areas under decking by natural ventilation, if approved by the Industrial Commissioner and subject to the following provisions:

1. "The rock surfaces for a distance of 30 feet from the heading or other drilling area shall be maintained in a damp condition.

2. "Hand-held drills (maximum piston bore, 3") minimum rate of water flow through drill steel, 0.75 gallon per minute; maximum rate of air flow through drill steel at full speed, 2.0 cubic feet per minute; maximum rate of air flow through the drill steel at half-speed operation, 1.0 cubic foot per minute; minimum rate of general ventilation in the drilling area, 500 cubic feet per minute per drill and shall be increased if found upon tests by the Industrial Commissioner that the dust concentration is not in accordance with the requirements of the Code.

3. "Drifter-mounted and wagon-mounted drills (maximum piston bore, 4") minimum rate of general ventilation per drill in the drilling area, as shown in the table 'Limitations in Air and Water Flow Through Steel.'

4. "In the case of positive-pressure ventilation, the air must be well distributed over the drilling and must not create drafts

at the various drilling positions, in a manner satisfactory to the Industrial Commissioner. The intake for the ventilating system must be located at a point free from contamination with dust or provided with an efficient filter.

5. "In the case of exhaust ventilation, the location of the intake pipe or pipes must be such as to insure the removal of air from the entire drilling area in a manner satisfactory to the Industrial Commissioner.

6. "The required ventilation may be obtained by means of a recirculating air-cleaning apparatus provided the dust concentration in the air at the breathing zone of the drill operators is maintained at a level below that required in Rule 33-2.3 and the apparatus is otherwise acceptable to the Industrial Commissioner.

7. "The above rates of ventilation shall be increased whenever necessary to reduce dust concentration to the amount permitted by Rule 33-2.3."

Proper blasting practice.—Methods of controlling dust and fumes in mines by proper blasting practice have been determined by members of the Bureau of Mines staff by observation and experiment.²² If at all feasible, blasting should be done at the end of the working shift or on an off shift, and the dust- and gas-laden air should be removed or thoroughly diluted before the men return to work. Ventilation is an essential agency in cleansing the air where blasting has been done. Results of investigations by the Bureau of Mines²³ show settling rate of dust after blasting under the following conditions:

1. The atmosphere was bratticed off for 3 hours while the dust samples were being taken. In this period, under these conditions, the dust concentration dropped from approximately 5,000 million particles per cubic foot to 50 million particles per cubic foot.

2. The atmosphere was bratticed off until 26 minutes after blasting when the brattice was raised and natural ventilation (which was virtually negligible except for eddy currents was allowed to dilute the dust-laden air. It required 2 hours and 20 minutes after blasting for the dust concentration to drop from approximately 5,000 million particles per cubic foot to 50 million particles per cubic foot, and 2 hours and 50 minutes to drop to 15 million particles per cubic foot.

3. The atmosphere was bratticed off until 37 minutes after blasting, when the brattice was raised and 10-inch canvas tubing installed to about 50 feet from the face. At 46 minutes after blasting, about 1,000 cubic feet of air per minute was forced into the face. It required 66 minutes after blasting for the dust concentration to drop to 50 million particles per cubic foot, and 70 minutes to drop to 15 million particles per cubic foot.

The accompanying table shows the time, in minutes, required for the dust concentration to drop from 825 million particles per cubic foot to 50 million and to 15 million particles per cubic foot under the three different conditions:

Ventilating Condition	Time, in minutes, to drop from 825,000,000 particles per cubic foot to—	
No ventilation.....	121	181
Natural ventilation....	105	135
Mechanical ventilation	20	24

In addition, the place (walls, floor, roof or top, and timbers) should be wetted thoroughly before blasting is done, and a water blast should be used during and after the blasting. The region should be wetted thoroughly when the men return to the face region after blasting, and the muck pile should be kept well wetted at all times while it is loaded out, as the water not only lays the dust but also either absorbs or otherwise aids in diluting or eliminating harmful or poisonous gases that follow blasting and that usually cling to the blasted material.

Tests²⁴ on the effectiveness of a spray of water mist in reducing the concentration of dust in the air after blasting and during mucking of the blasted material were conducted in three headings in medium hard to hard rock. The use of the spray apparently made it possible to reduce the concentration of dust generated and thrown into the air during blasting more than 99 per cent from the amount present when the spray was not used. Dust dissemination during mucking of material sprayed several hours before mucking was begun was much less than during shoveling of material thoroughly sprinkled just before and during mucking; and, of course, the dust present after use of either the spray or the sprinkling method is

far less than if the mucking had been done dry.

In general, the larger the quantity of explosive used, the more finely divided the blasted material, the more heavily the air will be impregnated with dust and smoke, and the greater will be the quantity of poisonous gases left at the place; hence, methods should be used that will tend to reduce the quantity of explosives used and of gases and dust produced. In this connection it will be found that the use of stemming or of some types of blasting plugs now available will confine more definitely the explosive, hence, increase its efficiency and reduce the quantity of explosive used and also reduce the amount of poisonous gas produced and possibly reduce the violence of the blast and its tendency to raise dust and disseminate it into the surrounding air. It would be well for users of explosives to investigate types of explosives that are known to give off minimum quantities of harmful gases on detonation and to use them; also, the discontinuance of the use of fuse and the substitution of electric blasting would aid in reducing the amount of poisonous gases from blasting. Explosives that have been held in storage too long or that have been stored under unfavorable conditions as to moisture, temperature, etc., are likely to give off maximum quantities of harmful gases, if they detonate at all; hence, utmost care should be taken in the storing of explosives to see that they are not held too long before being used.

Personal respirator protection.—This method of control of air dustiness is unsatisfactory in underground mining except for temporary use in emergencies. Although dust respirators give adequate protection against dust, they afford the wearer essentially no protection against toxic or asphyxiating gases, and are too cumbersome and uncomfortable for constant wear.

The Bureau of Mines has established a schedule of minimum requirements for mechanical respirators, one type of which is for protection against dust generated by disintegration as in drilling and blasting. About 30 respirators have been approved under this schedule.

Physical examination.—Although strictly speaking physical examination is not a dust-control measure, it is an important means of determining the efficacy of the methods em-

ployed to reduce the dust hazard. If workers exposed to dust are examined periodically increased incidence of respiratory disease can be discovered and measures taken to reduce the amount of dust in the air or remove any affected workers to a less hazardous environment.

In South Africa all white applicants for underground work are examined and certified to be physically fit and free of any disease of the respiratory organs and then re-examined every 6 months to determine and report all cases of simple silicosis, tuberculosis with silicosis, and simple tuberculosis that may have developed. In this way comparable records can be obtained for measuring the degree of pneumoconiosis and the extent of impairment of working capacity among employees from year to year. Comparable records will not be obtained unless periodic examinations are conducted in a standardized way, preferably by a permanent medical board composed of physicians specially trained and having adequate experience in the diagnosis of pulmonary diseases.

Summary

1. The principal pulmonary diseases to which the miner is subject are bronchitis, influenza and pneumonia, pulmonary tuberculosis, anthracosilicosis, and silicosis.

2. Statistics indicate that much higher morbidity and death rates from pulmonary diseases are experienced in dusty than in nondusty industries, especially where silica dust is used or produced.

3. Investigations by the Public Health Service reveal that hard-coal miners suffer a high mortality rate from influenza and pneumonia not only during influenza epidemics but at other times as well. In 1915-23 and 1906-25 influenza and pneumonia were responsible for 40 per cent of the total deaths among hard-coal miners compared with 25 per cent among males at ages 15 to 65 who were engaged in pursuits other than coal mining. Six per cent of hard-coal miners had pulmonary tuberculosis compared with 2 per cent in the adult male population of the United States. The rate for metal miners is still higher.

4. Anthracosilicosis was found in about 23 per cent of 2,711 employees of three anthracite mining companies studied by the United States Public Health Service in 1933.

About 63 per cent of those having anthracosis showed evidence of disability, compared with less than 10 per cent in the control group. Moderate and marked degrees of disability handicapped approximately 21 per cent of those with anthracosis compared with less than 2 per cent of the men serving as controls.

5. The occupational groups in anthracite mining, arrayed by the Public Health Service according to extent of physical impairment, are (1) rock workers, (2) regular miners, (3) all others exposed to more than 100 million dust particles per cubic foot of air, and (4) men in haulageways except rock workers.

6. The principal pulmonary disease in metal mines is silicosis and the chief menace in silicosis is tubercle infection. Apparently silica dust alone increases the liability to pulmonary tuberculosis.

Joint studies made by the Actuarial Society of America and the Association of Life Insurance Medical Directors²⁰ revealed that there were 65 deaths where 6 were expected (about 11 times the expected number) from tuberculosis in 1925-1936 among a group of underground miners, most of whom were employed in metal mines. Tuberculosis deaths were fourteen times the expected among copper miners, nine times the expected among gold and silver miners, and eight and a half times the expected among iron miners. In an earlier study²¹ covering the years 1915-1926, there were 18 times as many deaths as expected among lead and zinc miners.

7. As dust is the greatest contributor to the excessive mortality from pulmonary diseases in the mining industry, the principal method of preventing these diseases is to eliminate as far as possible or reduce to harmless concentrations the dust in the breathing zone of the worker.

8. The aim should be to eliminate the dust entirely from the air breathed. Where this is not always feasible it may be possible to reduce the dust to a concentration that will not cause disability during a working lifetime.

9. Analysis of data collected by the Public Health Service to determine safe limits of dust exposure indicate that employment in an atmosphere containing less than 50 million dust particles per cubic foot produces a negligible number of cases of sili-

cosis when the quartz content of the dust is less than 5 per cent; when the silica content is about 13 per cent 10 to 15 million particles appears to be a safe limit.

10. The amount of harmful dust created by various activities in mining can be determined by sampling the atmosphere in their vicinity and counting and identifying the dust particles. Sampling of air is also a means of checking the efficiency of dust control measures.

11. The impinger is the dust-sampling instrument used most frequently in the United States.

12. The dustiest operations in mining are dry drilling, blasting of dry rock or ore, shoveling or mucking, loading and haulage, and machine coal cutting.

13. The principal measures for controlling the ill effects of dust in mining operations are ventilation, wet methods, proper blasting practice, the use of personal respiratory protection, and physical examination of workers.

14. The efficiency of these measures in the reduction of the incidence of dust diseases is attested by the experience in the mines of South Africa where among the whole body of miners the liability to contract silicosis in 1936-37 was less by 65 per cent than it was in 1920-33. Among the "new Rand miners" who entered the industry by way of initial examination since 1916 and who have been exposed solely to the progressively improving occupational conditions that have obtained since that date, the liability to contract silicosis was less by 87 per cent than the similar liability among all miners working for an equal period in 1920-23. These "new Rand miners" constituted 77 per cent of all working miners examined.

Conclusion

The mortality and morbidity from pulmonary diseases are excessive in the mining industry as a result of exposure to large amounts of dust in the air breathed. Therefore, control of the dust hazard is necessary to prevent these diseases. No single means of control is applicable to all dusty operations and processes, therefore, all the means of prevention must be practiced to insure success in the solution of the problem.

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