Bulletin 44

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
JOSEPH A. HOLMES, DIRECTOR

FIRST NATIONAL MINE-SAFETY DEMONSTRATION

PITTSBURGH, PA., OCTOBER 30 AND 31, 1911

BY

HERBERT M. WILSON AND ALBERT H. FAY

WITH A CHAPTER ON THE EXPLOSION AT THE EXPERIMENTAL MINE

BY

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FIRST NATIONAL MINE-SAFETY DEMONSTRATION, PITTSBURGH, PA., OCTOBER 30 AND 31, 1911.

INTRODUCTION.

The national mine-safety demonstration at Pittsburgh, Pa., was projected and undertaken in the hope that it would aid the increase of safety in the mining industry.

That the national mine-safety demonstration was warranted and has served a useful purpose was evidenced by the attendance, not only at the public demonstration in Forbes Field, but also at the more special exhibit of the work of the Bureau of Mines at the arsenal grounds and at the experimental mine. Nearly 2,000 persons witnessed the demonstrations and exhibits of the Bureau of Mines at the arsenal grounds on the morning of October 30, 1911. The spectators were all mine operators, miners, or persons interested in mining, and represented operations in all parts of the United States. Nearly 1,200 of these persons visited the bureau's experimental mine at Bruceton to witness the explosion of coal dust. Had the weather, which was exceptionally inclement, been more favorable, there would doubtless have been a much larger attendance.

At the public demonstration in Forbes Field, which was witnessed by President Taft, from 12,000 to 15,000 persons, chiefly mining men, were present and attested their interest and enthusiasm in the mine-safety exhibits by remaining throughout the proceedings, regardless of the rain which fell all the morning. Since this demonstration, the organization of first-aid corps and of rescue corps has been undertaken at mines where there had previously been no such organizations. The bureau has received letters of commendation attesting the value of the demonstration in drawing attention to the dangers and to possible means of greater safety in mining. Many of these letters have urged that the results of the demonstration be published for the guidance and instruction of those who were present.

In response to these requests the following account of the mine-safety demonstration has been prepared. In its preparation various division and section chiefs of the Bureau of Mines have cooperated. The authors acknowledge the assistance they have received from those section chiefs and other members of the bureau who contributed detailed descriptions of apparatus exhibited at the demonstration or of investigations represented.

In lending its support to public demonstrations of first-aid and rescue work the Bureau of Mines has in view the encouragement of methods and appliances best adapted to preventing accidents and to increasing safety in mines. Prompt treatment of injuries by persons skilled in first-aid methods reduces the miner's loss of time by about 90 per cent. There is a corresponding saving in wages to the worker and a reduction of damages or compensation charges to the operator. Where mine operators take an interest in and encourage first-aid work a better feeling develops between the worker and his employer, resulting in improved hospital and sanitary arrangements, improved living and housing conditions, and the general advancement of the mining industry.

Experience indicates that the best results are effected by training in first-aid work at least one mine worker in every ten. This precaution insures the presence near the place of accident of enough first-aid men to give prompt treatment. Public exhibits and contests stimulate the interest of miners in organizing a first-aid corps and keep them prepared to render the most effective service. Such exhibits and contests have for several years been held annually by the various coal companies and groups of coal companies in the anthracite region, and within the last year they have been held by the employees in various other coal-mining sections. The national mine-safety demonstration was conceived as a means of further stimulating such interest and as an object lesson to those who had not adopted first-aid instruction or instruction in the use of artificial breathing devices and life-saving apparatus.

Those who attended the demonstration will understand that the Bureau of Mines is prepared to render to States or to mining companies such advice or assistance as may be necessary to establish local life-saving, fire-fighting, and first-aid corps. This bulletin is published as a further means to this end, in order that those concerned who did not attend the demonstration may have their attention attracted to the bureau and its purpose. Mine owners, mine operators, inspectors, and miners are invited to call freely upon the bureau for advice and suggestion as to mine safety. It is the hope of the bureau that in the course of time each coal-mining State may have one or more mine-safety cars or stations which, after the manner of those provided by the State of Illinois, will become local centers for rescue operations and for the instruction and organization of similar private stations at the mines.

EVENTS LEADING TO THE DEMONSTRATION.

As has been said, one of the main purposes of the Bureau of Mines is to increase safety in mining; consequently the bureau took an active part in the events that led to the holding of the demonstration. On

September 17, 1910, the director, Dr. J. A. Holmes, addressed the first first-aid meeting of the Philadelphia & Reading Coal Co. at Mahanoy Junction, Pa. On the same day H. M. Wilson, engineer in charge of the bureau's experiment station at Pittsburgh, attended and addressed the annual intercolliery first-aid meeting at Inkerman Park, near Scranton, Pa. Mr. Wilson then discussed with Dr. M. J. Shields, field demonstrator of the American National Red Cross, the possibility of holding, in 1911, a first-aid contest in the bituminous coal fields at the bureau's Pittsburgh experiment station and the possibility of making this an annual interstate affair.

Upon returning to Washington, Director Holmes immediately added a first-aid course of instruction to the training already adopted for the bureau's mine-safety stations and mine-safety cars. Through the courtesy of the American National Red Cross, Dr. Shields at once took up the instruction at Pittsburgh of the bureau's miners who were to be trained as foremen of the mine-safety stations and of the mine-safety cars. The work of the stations and the tours of the cars started late in October, 1910. Within a few months the popularity of the instruction in first-aid work and in the use of breathing apparatus was such that the holding of contests was given early consideration by the mine officials and workers in various coal fields outside of the anthracite region in which such instruction was then being introduced for the first time.

During this period the officials of the Bureau of Mines conferred informally with coal-mine operators, mine workers, and others regarding the possibility of holding annual first-aid meets in the bituminous regions of Pennsylvania, Alabama, Indiana, Colorado, Washington, and elsewhere, and as a result there developed evidence of a general desire for a national meet.

In April, 1911, an informal conference was held in the director's office at Washington. Those present were Maj. Charles Lynch, United States Army, director of the first-aid department of the American National Red Cross; W. J. Richards, vice president and general manager of the Philadelphia & Reading Coal and Iron Co.; and J. A. Holmes, H. M. Wilson, and Van. H. Manning, of the Bureau of Mines. It was decided that a national first-aid meet should be held in Pittsburgh on September 16, 1911, and that this should preferably be an exhibition of skill in first-aid work rather than a contest for prizes. Subsequent correspondence with the more prominent coal-mining officials of various parts of the country, especially of the anthracite region, where most experience had heretofore been had in conducting such affairs, led to a decision in favor of an exhibition rather than a contest. Subsequent conferences were held with members of the Committee on Mines and Mining of the House of Representatives, especially with the chairman, M. D. Foster, of Illinois, and W. B. Wilson, of Pennsylvania, also with President John P. White, Vice President Frank J. Hayes, and District President Francis Feehan, of the United Mine Workers of America, and with several of the State mine inspectors. As a result it was decided that the affair should be not only a first-aid exhibit, but also a general demonstration of various means of procuring safety in mining, including in particular a demonstration of rescue methods with breathing apparatus and of the relative merits of permissible and nonpermissible explosives. As indicative of the general aim of the demonstration the motto printed at the top of each page of the program might be cited. This motto was "Safety First," and was printed in English, Italian, French, Slavic, Polish, and several other languages.

VOLUNTARY CONTRIBUTIONS.

Conferences on financing the affair were held with President W. K. Fields and Secretary S. A. Taylor, of the Pittsburgh Coal Operators' Association. These officials promptly volunteered, on behalf of their association, to finance the demonstration, and the association ultimately contributed $1,000 toward the programs, a band of music, banners for presentation to coal companies represented, souvenir badges, and other incidentals.

The American National Red Cross, through Maj. Charles Lynch, acting in behalf of Miss Mabel Boardman, chairman of the executive committee, undertook to furnish souvenir first-aid boxes for each first-aid team exhibiting and a souvenir badge to each individual of the team, and toward this purpose, John Hays Hammond volunteered a special contribution.

The explosives manufacturers of the United States, through Joseph Burton, voluntarily undertook to provide the funds for the construction of a steel gallery in which to exhibit the effect of firing permissible explosives in the presence of coal dust, and subsequently bore the total expense, $1,050, of this feature.

The Pittsburgh Baseball Club, through its president, Barney Dreyfuss, tendered the use of Forbes Field for the public exhibition.

BOARD OF MANAGERS AND COMMITTEES.

In June, when the preliminary arrangements had been in part perfected, the director of the bureau, being about to absent himself in the West and in Alaska for several months, suggested the creation of a board of managers to conduct and assume entire responsibility for the demonstration. Thereupon the following board, representing the six national institutions interested, was organized: Herbert M. Wilson, representing the Bureau of Mines; Maj. Charles Lynch, United States Army, representing the American National Red Cross; S. A.

Taylor, representing the Coal Operators' Association; Francis Feehan, representing the United Mine Workers of America; John Laing, representing the State Mine Inspectors' Institute; and Thomas B. Dilts, representing the industrial department of the International Young Men's Christian Association.

Early in June, and immediately after the preliminary arrangements made by the board of managers of the first national mine-safety demonstration, the following general committee, composed of employees of the Bureau of Mines, to have immediate charge of the details, was appointed: Herbert M. Wilson, chairman; J. W. Paul, mine-rescue and first-aid work; Clarence Hall, arsenal demonstration; L. M. Jones, experimental mine; Lauson Stone, program; A. W. Belden, reception; J. K. Clement, ushering; and C. S. Stevenson, secretary.

Each of the above was appointed a chairman of a subcommittee composed of other bureau employees, and to these men, and the field officials subsequently appointed, is due in large measure the success of the demonstration. Special mention should also be made of the valuable assistance rendered by a number of other persons, notably G. S. Rice, through his responsible and energetic work in connection with the explosion at the experimental mine, and certain clerks and other employees of the Bureau of Mines who attended to various details connected with the perfecting of arrangements for the several events.

The following committee of field officials was appointed in September to assume charge of all arrangements concerning the demonstration at Forbes Field: Manager of field events, J. W. Paul; manager of first-aid events, Dr. M. J. Shields; manager of explosion, Clarence Hall; field marshal, Francis Feehan; chief usher, J. K. Clement.

About the 1st of October, upon the return from Alaska of Director Holmes, with the concurrence of the Secretary of the Interior, the following special reception committee to the President was appointed: Senator George T. Oliver, Representatives John Dalzell, A. J. Barchfeld, James Francis Burke, and S. G. Porter, of Pennsylvania; W. A. Magee, mayor of Pittsburgh; J. A. Holmes, Director of the Bureau of Mines; F. R. Babcock, president of the Pittsburgh Chamber of Commerce; and W. H. Stevenson, president of the Historical Society of Western Pennsylvania. Much credit is due to this committee for the smoothness with which the two civic events arranged for the President on October 31 were made to coordinate with each other and with the mine-safety demonstration. The two civic events referred to were the marine parade, celebrating the centenary of steam navigation on the western rivers, and the banquet given by the chamber of commerce.

The managers of the national mine-safety demonstration and the Director of the Bureau of Mines are also indebted to the Illinois Mine Rescue Station Commission, to the Philadelphia & Reading Coal & Iron Co., and to the Pittsburgh-Buffalo Co. for sending corps of men to participate in the rescue exhibition, to the Illinois Mine Rescue Station Commission for sending a mine-rescue car, and to the American National Red Cross for sending a hospital car.

INVITATIONS SENT OUT.

On June 26 Director Holmes addressed a circular letter to all coal-mining companies known or believed to be interested in first-aid work, inviting them to enter teams in a first annual national first-aid field meet, to be held in Arsenal Park, Pittsburgh, September 16, 1911. On July 12 a second circular letter was addressed to all coal-mine operators believed to be interested, to all State mine inspectors in the United States, to officials of the United Mine Workers of America throughout the United States, to State geologists, to professors of mining engineering in colleges and universities, to Canadian and foreign departments of mines, to a large number of mine surgeons, and to other persons believed to be interested. The letter stated that arrangements had been definitely perfected for a first national mine-safety demonstration, to be held in Forbes Field, Pittsburgh, Pa., October 27, and invited active cooperation and the entering of first-aid teams. Subsequent communications advised of the postponement of the date to October 31, on account of the desire of President Taft to be present and of his preference for that date. Because of requests received from mine operators and others, October 30 was assigned as the date for a public demonstration by the Bureau of Mines of its work at the arsenal grounds, Pittsburgh, and at the experimental mine at Bruceton, near Pittsburgh. Subsequently, special invitations were sent by Director Holmes to about 1,500 persons outside of those connected with mining but who were known to be interested in first-aid work or in the work of the Bureau of Mines, or for especial reasons might desire to be present. These included all Members of Congress, governors of mining States, Cabinet officers and chiefs of bureaus in Washington, explosives manufacturers, prominent operators of metal mines, manufacturers of mining machinery, and officials of railways interested in coal mining and coal transportation and over whose lines the mine-safety cars of the Bureau of Mines were, by courtesy, gratuitously transported.

DETAILED PROGRAM.

In order to give a comprehensive idea of the demonstration as a whole and as a means of reference, the detailed program is presented below:

MONDAY MORNING, OCTOBER 30.

BUILDING NO. 21. CHEMICAL AND PHYSICAL LABORATORIES.

Operations 1 to 10 will be continuous from 8.30 a. m. to 10.00 a. m.

[Operations or event numbers are in brackets.]

[*1*] *Room 4, physical laboratory.*—Measurement of high temperatures; calibration of physical apparatus and instruments; determination of thermal conductivity at high temperatures; investigations of the explosibility of mine gases.

[*2*] *Room 3.*—Determination of heating values of solid and liquid fuels in the bomb calorimeter.

[*3*] *Boiler room.*—Operation of hand-fired return tubular boiler arranged for smoke prevention. Several types of heating boilers.

Room 8.—Library.

Rooms 15, 17, and 19.—Mining-engineering investigations.

[*4*] *Second floor: Room 22, fuel laboratory.*—Proximate and ultimate analysis of coal, lignite, peat, and coke. Analysis of mine and boiler water, coal, ash, and slag.

[*5*] *Room 21, petroleum laboratory.*—Inspection and analysis of fuel oils, petroleum investigations.

[*6*] *Rooms 23 and 25.*—Research on the chemical constitution of coal; investigation of the relative explosibility of coal dusts.

[*7*] *Room 28, gas laboratory.*—Investigation of mine air and natural gas; gas-analysis apparatus; examination of natural gas for gasoline manufacture; physiological effects of noxious mine gases.

[*8*] *Rooms 27, 29, and 31.*—Investigations of destructive distillation of coals; weathering and spontaneous combustion; occluded gases in coal.

[*9*] *Room 30.*—Photographic laboratory.

[*10*] *Rooms 32, 33, and 34, explosives laboratory.*—Analysis of black powder, dynamite, and permissible explosives; testing the stability of explosives; strength of detonators, danger of exudation of nitroglycerin explosives.

Event No. 11 will take place at 10 a. m. in front of building No. 17 at lower end of arsenal grounds.

[*11*] *Address of welcome.*—Dr. J. A. Holmes, Director of the Bureau of Mines.

Operations [12] to [20] will be continuously running from 10 a. m. to 12 a. m., and may be witnessed at intervals between the scheduled operations [11] and [20] to [24]. They are conducted for the purpose of devising methods for the conservation either of human life or mineral resources.

[*12*] *Building No. 10—Breaking lighted incandescent lamps* in an explosive ~~mixture of gas and air; illustrating their relative safety.~~

[*13*] *Building No. 13—Foundry cupola,* showing method of taking gas samples and temperatures in the various zones of the coke bed, for the purpose of studying the fundamentals of the process, with a view to possible improvement.

[*14*] *Gas producer* burning fuel at high temperature and capacity, accumulation of ash and clinker removed by tapping off the liquid slag periodically.

[*15*] *Smokeless combustion* of low-grade, high-volatile fuel in boiler furnaces using mechanical stokers.

[16] *A long combustion chamber* used to investigate combustion in boiler furnaces, and the conditions necessary for complete combustion of coals of various composition, when rate of firing and air supplied through grate and above fuel bed varies.

[17] *Building No. 17—Single and double gauze safety lamps* in a current of air of a known velocity containing 8 per cent of methane and ethane; a demonstration of their relative safety.

[18] *Men wearing various types of breathing apparatus* training in noxious atmosphere.

[19] *Exhibition of apparatus for the physical testing of explosives.*—Ballistic pendulum, pressure gage, calorimeter, flame-testing apparatus, rate of detonation apparatus, large and small impact machines, cone and pendulum friction devices, Trauzl and small lead blocks.

[20] *Building No. 32—Lignite and coal briquetting plant.*—Making briquets from California lignite.

10.30 a. m. [21] *Gas and dust explosion gallery No. 1.*—A "permissible explosive" equivalent in deflective force to ½ pound of 40 per cent nitroglycerin dynamite tamped with 1 pound of dry fire clay, is fired into a mixture of gas and air containing 7 per cent of methane and ethane.

NOTE.—At Forbes Field, October 31, events [21] and [23] will be repeated in the presence of coal dust instead of mine gas.

10.45 a. m. [22] *Near gas and dust gallery No. 1.*—Ignition of coal dust by means of laboratory coal-dust ignition apparatus.

11.00 a. m. [23] *Gas and dust explosion gallery No. 1.*—Black blasting powder, FFF, equivalent in deflective force to ½ pound of 40 per cent nitroglycerin dynamite tamped with 2 pounds of dry fire clay, fired into a mixture of gas and air containing 7 per cent of methane and ethane.

11.30 a. m. [24] *Gas and dust gallery No. 2.*—Electric mine motor, operating in an explosive mixture of gas and air, has explosion-proof protective devices removed, causing an explosion.

MONDAY AFTERNOON, OCTOBER 30.

[25] *Explosion at experimental mine, near Bruceton, Pa.*—2.00 p. m., leave Pittsburgh by special train from Baltimore & Ohio depot, Smithfield and Water Streets; 2.30 p. m., arrive at experimental mine; 2.30 to 3.30 p. m., inspection of experimental mine; 3.45 p. m., explosion in experimental mine; 4.00 to 4.45 p. m., inspection after explosion; 5.00 p. m., return to Pittsburgh by special train.

TUESDAY MORNING, OCTOBER 31, 1911.

FORBES FIELD, PITTSBURGH, PA., 9.00 A. M. TO 10.30 A. M.

[26] *First-aid exhibition.*—Demonstration of first aid to the injured by teams of trained miners representing mining companies from all sections of the United States of America, who will perform alternately in two sections. Watch the score board for the number of the event in progress.

ORDER OF EVENTS.

[Odd-numbered teams demonstrate odd-numbered problems; even-numbered teams demonstrate even-numbered problems.]

1. Treat a lacerated wound of the right side of head (temple) and a lacerated wound on top of the right shoulder; one-man event.
2. Treat a punctured wound over the left eye and lacerated wound of palm of right hand; one-man event.

3. Treat a simple fracture of left collar bone and simple fracture of jaw; two-men event.
4. Treat a dislocated right shoulder and simple fracture of right leg; two-men event.
5. Rescue and treat a man who has fallen on an electric wire, back down, clothing burning; rescue, extinguish fire, treat back and upper arms; team event.
6. Rescue and treat a man who has fallen on an electric wire, face down; rescue, extinguish fire, treat chest and upper arms; team event.
7. Treat gas burns of face, neck, ears, and hands; team event.
8. Treat gas burns of hands, right arm, and shoulder; team event.
9. Treat a broken back and simple fracture of right forearm; team event.
10. Treat a dislocated hip and simple fracture of collar bone; team event.

EXPLOSION, RESCUE, AND FIRST AID AT STEEL EXPLOSION GALLERY.[a]

10.40 a. m. [27] [b] *A permissible explosive*, equal in disruptive force to one-half pound of 40 per cent nitroglycerin, tamped with 1 pound of dry fire clay, will be fired into the gallery. No explosion of the coal dust is expected.

MINE-GAS TEST.

10.45 a. m. [28] *The use of birds in exploring mines* after explosions or mine fires, at which carbon monoxide causes a large percentage of the fatalities. A few birds, which are much more sensitive to the effect of poisonous gas than men, can be taken into a mine with a rescue party, and as soon as they show signs of distress the party can retreat to safety. In the demonstration a man (G. A. Burrell, Bureau of Mines) will enter a glass box the atmosphere of which contains 0.25 of 1 per cent of carbon monoxide gas (the miner's white damp) and remain there for some time after the birds have collapsed. The birds will subsequently be resuscitated by oxygen.

EXPLOSION.

11.05 a. m. [29][b] *A charge of FFF black powder*, equal in disruptive force to ½ pound of 40 per cent nitroglycerin, tamped with dry fire clay, will be fired into the gallery containing 153 pounds of bituminous coal dust, being the same kind of dust as that used in the preceding event [27]. An explosion of coal dust is anticipated.

RESCUE.

11.05 a. m. [30] *Rescue party of foremen miners* of the Bureau of Mines, aided by squads representing the Illinois Mine Rescue Station Commission, the Philadelphia & Reading Coal & Iron Co., Pittsburg-Buffalo Co., and other local coal companies, and equipped with various types of artificial breathing apparatus, will enter the gallery immediately after the coal-dust explosion and recover three supposed victims of mine explosion, bring them from explosion gallery and place them in care of squad of foremen miners and first-aid miners of the Bureau of Mines, who will demonstrate the proper treatment of the following accidents, using the pocket first-aid packet only and such things as might be available in a mine after an explosion:

Accident 1. Miner overcome by afterdamp and having lacerated scalp. Treated by C. O. Roberts.

[a] Forbes Field explosion gallery is cylindrical, 133 feet long, of an internal diameter of 6 feet 4 inches, and represents an underground tunnel or part of a coal mine. The explosive is fired into the end of the gallery, within which are 133 pounds of fine coal dust from the Pittsburg bed, distributed uniformly throughout, and 20 pounds on a wooden bench 20 feet long near the mouth of the cannon, making a total of 153 pounds of coal dust.

[b] Event [27] illustrates the safety in using a permissible explosive in a dusty mine. Event [29] illustrates the danger in using black powder in a dusty mine.

Accident 2. Miner slightly overcome by afterdamp and suffering from simple fracture of right thigh and compound fracture of right forearm near wrist. Treated by W. A. Raudenbush and William Burke.

Accident 3. Miner overcome by afterdamp and suffering from simple fracture of right collar bone and simple fracture of left arm. Treated by W. D. Roberts and J. T. Ryan.

11.10 a. m. [*31*] *Second rescue party* brings two miners from explosion gallery as soon as first three have been dressed and placed in ambulance. These are placed in the care of first-aid squad, who in the meantime have been provided with bandages and first-aid supplies.

Accident 4. Miner overcome by afterdamp and burned about face, neck, ears, and hands. Treated by W. A. Raudenbush and William Burke.

Accident 5. Miner overcome by afterdamp and burned from waist line up. Treated by W. D. Roberts, C. O. Roberts, and J. T. Ryan.

MINE-RESCUE BREATHING APPARATUS.

A mine-rescue breathing apparatus is a self-contained device, the wearer of which can penetrate the zone of irrespirable gases formed by mine explosions or mine fires.

There are several types of breathing devices, one of which depends on liquid air for the breathing supply, a second depends upon the generation of oxygen from a chemical compound, a third depends upon normal air under pressure, and a fourth, which is most generally known in America, depends upon pure oxygen under great pressure for its air supply.

The history of mine-rescue apparatus dates from 1868, when a device was used similar to the submarine diver's helmet. Practically all succeeding forms were built along similar lines until 1896, when the present portable self-contained type was devised and used abroad. The first of this type to be used in the United States were four imported in 1907 by the Anaconda Copper Co., of Butte, Mont. Mine-rescue breathing apparatus was purchased and generally used in September, 1908, by the technologic branch of the United States Geological Survey. To-day the Bureau of Mines has 7 rescue cars and 6 rescue stations in various States, equipped with over 120 complete sets of such apparatus, while over 1,000 sets are owned by States and mining companies having rescue corps trained in their use.

PRESENTATION OF TROPHIES, 11.30 A. M.

Presentation of trophies .... William H. Taft,
President of the United States.

Address .... John K. Tener,
Governor of the Commonwealth of Pennsylvania.

Address .... Walter L. Fisher,
Secretary of the Interior.

Address .... Miss Mabel Boardman.
~~American National Red Cross.~~

FORMAL OPENING OF THE DEMONSTRATION.

The demonstration was formally opened on the morning of October 30. At 10 o'clock in front of building No. 17, at the lower end of the arsenal grounds, addresses of welcome were delivered by Hon. Walter L. Fisher, Secretary of the Interior; Hon. John K. Tener, Governor of Pennsylvania; and Dr. J. A. Holmes, Director of the Bureau of Mines. In welcoming the mining engineers, inspectors, and miners, and in introducing Secretary Fisher, under whose department the Bureau of Mines is established, Director Holmes said:

The great purpose of the national mine-safety demonstration is to stimulate and encourage the movement for mine-rescue and first-aid work.

Of course, the aim of all this work should be the prevention of mine accidents, but everyone who studies the situation realizes that this will have to come by degrees, and that there probably will be some accidents as long as mining continues. In view of this fact, it is important that everything possible be done looking to the rescue of and prompt aid for miners that may be injured.

One feature of these demonstrations that will greatly stimulate the movement is the bringing together from all parts of the country of the miners who are leading in this rescue and first-aid work. Taking part in the Forbes Field demonstration to-morrow will be 40 or more teams of miners coming from every important coal-producing State, some of them from such far-away coal fields as those in the States of Washington and New Mexico; and those coming will be the prize winners—those who have already won the highest prizes as being the most skillful miners in this work to be found in the regions from which they come.

One benefit to grow out of this great demonstration will be the awakening of the public to a realization of the magnitude and growth of this movement; and it will stimulate the public to aid this movement in every way possible.

Again, this great demonstration will stimulate the establishment of local rescue and first-aid stations at many of the large collieries in different parts of the country, where either large individual operators or groups of operators will supply the equipment and the young, public-spirited miners will take the training and organize into first-aid and rescue teams.

Again, assemblages and demonstrations of this kind will help to bring about the better cooperation between the miners and the coal operators, the mine inspectors, the Bureau of Mines, and the Red Cross organizations. They also will stimulate inquiries and investigations and the development of better rules and regulations looking to the ultimate prevention of mine accidents.

Secretary Fisher said, in part:

The presence here of so large a body of mining men under such inclement conditions is the best evidence of the success of the endeavors of the Bureau of Mines to bring together mining men for the study of problems in which they, the General Government, and the States are mutually concerned. I urge you to do everything practicable to further cooperation between the miners, the mine owners, the Government officials, and all who are interested in the mining industry. Through such cooperation in the adoption of such measures for safety as may result from the investigations of the Bureau of Mines, the efficiency in mining and the methods which are rapidly being developed should result in a saving of the lives of many thousands of miners. Heretofore, for lack of proper apparatus and knowledge in its use, many lives have been sacrificed.

Speaking for the executive department of the Government, I can assure you that it will do everything possible to furnish all necessary aid to keep the local experiment station at a high plane of efficiency. The buildings now occupied here by the Bureau of Mines were erected for the War Department long ago and for other purposes. They are inadequate and unsuited to the needs of the bureau for this important work. The present arrangement should be only temporary. The work has increased and developed rapidly. The Government should, and doubtless will, at an early date see that this experiment station is provided with more and better buildings and larger grounds to house adequately all machinery and apparatus required for the proper prosecution of the varied and important work which Congress has authorized the Bureau of Mines to do.

I welcome you here to-day, and I shall gladly cooperate with you all in this great movement for safety and the prevention of waste in our mining, quarrying, and metallurgical industries.

Gov. Tener said:

I am glad to hear Secretary Fisher's encouraging words; he voices the Government's interest in extending the system providing for the safety of mines and in looking to the humanitarian care of miners. These are matters that call for our especial interest in Pennsylvania and for our acceptance of the Federal Government's invitation to cooperate in every measure possible. Personally, I am much interested in everything that tends to improve the conditions under which the miner works. At my home at Charleroi I live almost opposite the entrance of a coal mine, and all the dangers and dread which surround these noble toilers underground have been brought home to me. I shall be glad to see the State take any action that will support the Federal Government's splendid work. I am especially glad to see the large number of practical miners taking such an interest in the demonstration.

Both before and after the addresses of welcome, experiments concerning gas, electricity, explosives, and coal dust in coal mines were being carried out in the various laboratories; the details of these experiments are given in the following pages.

MINE-SAFETY EXHIBITS AT THE ARSENAL PLANT.

The mine-safety exhibits at the arsenal plant, in addition to special features, embraced demonstrations of routine work and of the equipment used in it; consequently descriptions of some of the important branches of that work are deemed fitting at this point. The order of operations indicated by the numbers on the program is not followed, but the work or the equipment of the plant is discussed in such order as to bring out prominently the main purpose of the demonstration, which was to emphasize the importance of safety precautions. A plan of the arsenal grounds, indicating the bureau's buildings and the numbers by which they are usually designated, is shown in figure 1.

GAS LABORATORY.

The gas laboratory (No. 7 on the program), in room 28, building 21, is engaged in the investigation of mine and natural gases. A study is being made of the gases produced when coal is broken down by explosives. These tests are being conducted with a view to suggesting the length of time a miner should wait before returning to the face after a blast and to determining the causes that lead to the production of noxious gases in the use of explosives.

A study is also being made of mine-fire gases. In connection with this investigation, analyses of gas taken from mine fires are made with the purpose of discovering possible means of extinguishing such fires. After a mine fire is sealed, gas samples can be taken from behind stoppings, and analyses can be made in order to determine the

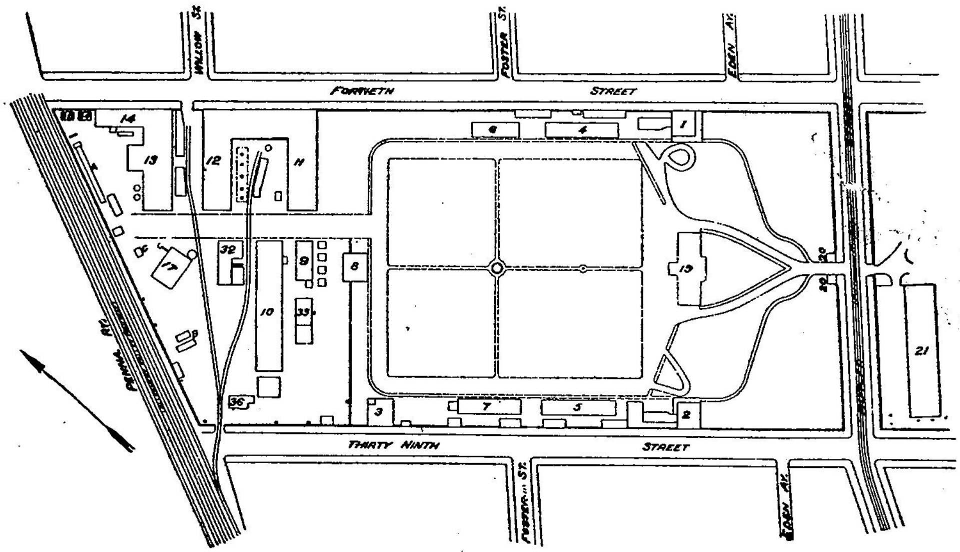


FIGURE 1.—General plan of grounds and buildings, Pittsburgh experiment station of the Bureau of Mines; 9, General offices; 10, electrical tests; 13, fuel-engineering tests; 17, explosives, helmet, and safety-lamp tests; A, gas and coal-dust gallery No. 1; B, gas and coal-dust gallery No. 2; 21, chemical and physical laboratories.

effectiveness of the stoppings for excluding air. Such analyses are also valuable when they represent the entire period during which the mine or section of the mine has been sealed, because they furnish a basis for reasonable conclusions regarding the length of time a fire should remain sealed.

Part of the work of the gas laboratory is the assembling of gas-analysis apparatus for all classes of mine-gas work—for research work and for laboratories at coal mines where chemists are employed. The laboratory also designs easily manipulated apparatus which may be used by mine inspectors, superintendents, or foremen.

Work is being done toward studying the effect of atmospheric pressure on the exudation of methane (CH_4) in mines, and also regarding the use of acetylene lamps in mines.

The gases produced by explosions in the experimental mine at Bruceton are analyzed and studied at this laboratory.

A complete series of samples of mine air has been collected and analyzed to show the composition of the air while a gasoline motor is used under varying conditions.

A series of experiments has been completed demonstrating the effect of carbon monoxide on canary birds, mice, pigeons, and men. This work will be extended so as to include the effect of hydrogen sulphide and the oxides of nitrogen.

Samples of gas have been obtained in connection with almost all of the explosions and many of the mine fires during the last two years. Some of the results are surprising, in that mines always considered nongaseous have been found to produce considerable methane. Much information has been obtained in this way regarding the cause of explosions.

This section also aims to help mining companies to install gas-analysis laboratories. Analyses of the ventilating current are of such aid in properly diluting methane in different parts of a mine that this work is considered very important.

In this laboratory control is exercised over all the natural gas and air mixtures used at the plant in testing explosives, safety lamps, incandescent lamps, explosion-proof motors, etc.

One of the problems investigated by this section is the extraction of gasoline from natural gas and the use of some of the residual material as liquid gas. A study has been made of the natural gases of southern California. The composition and properties of the Pittsburgh natural gas have been investigated.

The personnel is as follows[a]: G. A. Burrell, assistant chemist, in charge; F. M. Seibert, junior chemist; and E. N. Weisberger, laboratory aid.

ELECTRICAL SECTION.

The electrical section (No. 12 on the program), building No. 10, is particularly concerned with the problem of safeguarding life and property from the dangers that attend the use of electricity underground. It is the purpose of the section to attempt to discover the causes of accidents resulting from the use of electricity in mines, to suggest means for the prevention of such accidents, to make tests as to the safety of electrical equipment when used under conditions most conducive to disaster. and to make such general tests as bear upon the safety of electricity in mines.

The electrical laboratory is supplied with direct-current power in any voltage up to 750 volts and with alternating current up to 2,000 volts for power and up to 30,000 volts for high-potential tests. The

[a] The personnel of the Bureau of Mines, as given in this report, is that employed at the time of the exhibit.

laboratory is provided with a six-panel switchboard for the control of transformers, generators, and circuits; a complete equipment of alternating-current and direct-current instruments; a very delicate equipment for measuring insulation resistance up to 80,000 megohms; a high-potential testing transformer, and other miscellaneous equipment. In this laboratory is a small gas gallery for testing inclosed fuses, incandescent lamps, and other small pieces of electrical equipment. There is also an apparatus for testing the effect of electric flashes upon coal dust suspended in the atmosphere.

In the small gas gallery mentioned above, the following tests were conducted on October 30: Three 16-candle power, 50-volt, carbon-filament incandescent lamps and three 16-candle power, 220-volt, carbon-filament incandescent lamps were broken in a highly explosive mixture of natural gas and air. Each of the first three, but none of the last three, lamps exploded the gas. This test was made to show the relative danger from various sizes of incandescent-lamp filaments. It was supplemented by the display of 12 incandescent lamps of different sizes and voltages, each of which was marked to indicate whether it exploded gas when broken under normal conditions, or whether, and to what degree, the heat in the filament had to be increased before explosion occurred.

Outside the electrical laboratory and at some distance from it is a large testing gallery consisting of a cylindrical boiler-iron shell, 30 feet long and 10 feet in diameter, laid horizontally upon a concrete bed, and partly filled with concrete to form a floor upon which apparatus can be set up for test. Seven and one-half feet from either end the cylinder can be stopped off with heavy paper diaphragms that relieve the pressure from explosion before it becomes dangerously heavy. A large motor-driven centrifugal fan mixes and circulates the gas and air, and a special device has been developed to indicate the percentage of gas in the mixtures. Tests of explosion-proof motors, explosion-proof switches, and other large apparatus are made in this gallery.

In the gallery (No. 24 of the program) above described, an explosion-proof motor was operating in a highly explosive mixture of natural gas and air, viz, 8.6 per cent of gas to 91.4 per cent of air. The casing of the motor was filled and surrounded with this mixture. The motor was then started and the mixture inside the ~~motor casing was exploded. This test was repeated several times~~ during the forenoon, and in no explosion was the gas surrounding the motor ignited nor were any flames observed to issue from the motor casing. The test was intended to show the progress that has been made in designing so-called explosion-proof motors, that is, motors so constructed that an explosion of gas inside the motor casing will not start an explosion of gas surrounding it.

After the completion of the test above mentioned, the protective devices were removed from the motor, and the motor casing was once more filled and surrounded with the explosive mixture. On this occasion (as was anticipated) an explosion of all the gas in the gallery resulted, because the explosion inside the motor casing was readily communicated to the gas outside. The latter part of this test served to emphasize the danger of operating unprotected motors in the presence of gas. The first part of the test was of special interest as demonstrative of the possibility of so protecting motors that a spark inside the motor casing can not be communicated to gas surrounding it.

The work of this section is in charge of H. H. Clark, electrical engineer; L. C. Ilsley, assistant electrical engineer; and R. W. Crocker, junior electrical engineer.

EXPLOSIVES CHEMICAL LABORATORY.

At the explosives chemical laboratory (No. 10 on the program), rooms 32, 33, and 34, building 21, the methods of analyzing black powder, dynamite, and permissible explosives were shown; also the operations of testing the stability of explosives, tests for exudation of nitroglycerin, and the tests of electric detonators, detonating caps, and fulminating compounds. Apparatus for determining the gravimetric and absolute density of black powder and a device for determining the colors of explosives by reference to certain standards were also exhibited.

The operations involved in the analysis of dynamite were shown in detail from the first sampling of the cartridges through all the operations of determining nitroglycerin and other constituents. The electric drying ovens used in this work were shown in operation. The analysis of black powder and of fulminating compounds was also shown in detail, a number of samples of powder being under analysis at the time.

The testing of electric detonators proved of particular interest, in connection with an exhibit of new methods devised for testing the absolute strength of detonating compounds. The great exactness of the results obtained by the new method and a comparison of these results with the results obtained by methods formerly in use were shown by a series of tests. The protecting cabinet, in which nitroglycerin has been boiled and distilled, was shown, and the methods by which the illumination of this cabinet is effected, and the means of affording protection to the observer, were explained by the attendant.

The pressure tank, in which electric detonators are tested for waterproof qualities, was shown. In this tank the detonators are subjected to a pressure equivalent to that which they receive in the actual operations of blasting at a depth of 100 feet under water.

The color comparator and the exudation apparatus were shown in connection with the work of analyzing explosives for the Panama Canal. These apparatus, together with the devices used in determining the influence of temperature and pressure upon the rate of burning of time fuse, proved of particular interest to many visitors.

The following is the personnel of the explosives chemical laboratory: W. O. Snelling, chemist in charge; C. G. Storm, explosives chemist; A. L. Hyde and W. C. Cope, assistant chemists; C. A. Taylor and J. H. Hunter, junior chemists.

PHYSICAL TESTING OF EXPLOSIVES.

No. 19 on the program comprised a demonstration of apparatus for the physical testing of explosives, including the following: Ballistic pendulum, pressure gage, calorimeter, flame-testing apparatus, rate of detonation apparatus, large and small impact machines, cone and pendulum friction device, and Trauzl and small lead blocks.

BALLISTIC PENDULUM.

This apparatus is used to determine the unit deflective charge of explosives. It consists of a mortar, weighing 31,600 pounds, suspended as a pendulum, with a radius of swing of 89¾ inches. The swing is measured by a sliding scale. The explosive being tested is fired from a cannon into the mortar, the two being one-sixteenth inch apart. The unit deflective charge of the explosive is defined as that weight of the explosive that swings the mortar the same distance as one-half pound of 40 per cent "straight" nitroglycerin dynamite.

PRESSURE GAGE.

The pressure gage is a strong air-tight steel container having a capacity of 15 liters. It is used (1) to collect the solid, liquid, and gaseous products of explosives fired within it; and (2) to measure the pressure developed by an explosive.

CALORIMETER.

The calorimeter is an apparatus for determining the latent energy that an explosive develops in the form of heat. This is determined by measuring the increase in temperature of a known quantity of water that surrounds a bomb in which a small quantity of the explosive is exploded.

FLAME-TEST APPARATUS.

The flame-test apparatus consists of a cannon, within which the charge of explosive is fired; and a photographic apparatus having a photographic film that moves rapidly and always in focus. The photograph of the flame indicates both the height of the flame in inches and its duration in thousandths of a second.

RATE OF DETONATION APPARATUS.

The rate of detonation apparatus consists of a pit in which charges of explosives may be safely fired, and a very accurate chronometer—Mettegang's recorder—which measures the time required for the explosive wave to proceed from one point to another point in a column of the explosive. When run at its usual speed the recorder measures increments of time to $\frac{1}{4300000}$ second.

LARGE AND SMALL IMPACT MACHINES.

These machines are similar, differing in size only, the large machine being 100 times as large as the small machine. Each has a weight which may be dropped a known distance on to a steel plunger which fits squarely on a horizontal steel anvil. The explosive is placed between the plunger and the anvil. The falling weight for the large machine is 440 pounds, for the small machine 4.4 pounds.

CONE AND PENDULUM FRICTION DEVICES.

The cone friction device is for determining the sensitiveness of explosives to friction only. The salient feature of this device is a cone revolving on a vertical axis within a conical depression.

The pendulum friction device is an apparatus for determining the sensitiveness of explosives to frictional impact. It consists of a shoe that falls in the arc of a circle (radius of 7 feet) and strikes a glancing blow on a corrugated, horizontal base.

TRAUZL AND SMALL LEAD BLOCKS.

The Trauzl lead blocks are desilverized lead cylinders 8 by 8 inches, having an axial bore 1 inch in diameter and 5 inches deep, within which 10 grams of explosive is tamped and fired. This device was recommended by the Fifth International Congress of Applied Chemistry for determining the strength of "high" explosives. The small lead blocks are cylinders 1½ inches in diameter and 2½ inches long on which a charge of 100 grams of "high" explosive is placed. The compression of the lead cylinder indicates the quickness of the explosive.

GAS AND DUST GALLERY NO. 1.

The gas and dust gallery No. 1 (No. 21 and No. 23 on the program) is cylindrical, 100 feet long and 6 feet 4 inches in internal diameter. One end is closed by a steel plate. The gallery is arranged for accommodating (1) an explosive mixture of gas and air; (2) coal dust; and (3) a mixture of natural gas, coal dust, and air. The charge of explosive is fired into the gallery from a cannon through a hole in the end plate. Permissible explosives are required to pass three series of tests consisting of 25 trials in this gallery before being placed on the list of explosives permissible for use in coal mines. As an illustration of the series of tests in which the charge of explosives is fired into a mixture of gas and air, the following tests were made on October 30:

A permissible explosive, equivalent in deflective force to one-half pound of 40 per cent nitroglycerin dynamite, was tamped with 1 pound of dry fire clay and was fired into a mixture of gas and air containing 7 per cent of methane and ethane. Result—No explosion. The flame did not show in doorways or windows.

A charge of FFF black blasting powder, equivalent in deflective force to one-half pound of 40 per cent nitroglycerin dynamite, was tamped with 2 pounds of dry fire clay and was fired into a mixture of gas and air containing 7 per cent of methane and ethane. Result—Ignition; flame showed in all doorways and in all windows.

The work of this section is under the direction of Clarence Hall, explosives engineer; S. P. Howell, assistant engineer; and A. J. Hazlewood, H. F. Braddock, J. W. Koster, I. W. Robertson, and A. J. Strane, junior engineers.

COAL-DUST EXPERIMENTS.

The ignition of coal dust (No. 22 on the program) by means of laboratory coal-dust ignition apparatus was designed to give a demonstration of the explosibility of coal dust in air.

The apparatus used was assembled after the principle of the laboratory apparatus employed in measuring the relative inflammability of coal dust. It consisted of a 3-gallon aspirator bottle of thick glass in which was suspended, through a rubber stopper closing the mouth of the bottle, a coil of about 5 feet of No. 26 platinum wire. Through a hole in the same stopper, connection was made by means of a glass tube with a light-walled Florence flask of about 1-quart capacity, the glass tube passing through a second rubber stopper firmly fastened in the mouth of the flask. The stopper of the aspirator was held gas-tight and firmly in place by means of steel pieces bolted to a wooden collar around the neck of the bottle. The tubulature in the bottom of the aspirator bottle was closed by means of a one-hole rubber stopper containing a copper funnel bent at a right angle and directed upward inside the bottle under the platinum coil. The stopper was firmly held in place by careful wiring. The funnel contained one-sixth ounce of fine coal dust. To the projecting end of the copper funnel was attached a thick rubber tube leading to a 2-quart bottle, containing air under pressure and provided with a pinch cock for releasing the pressure at the proper time. For protection to the operators and observers the whole apparatus was inclosed in a box, one side of which was thick plate gas, through which the inflammation could be observed. The platinum coil, the source of ignition, was heated to a bright redness by an electric current, until the air immediately surrounding it in the bottle had become quite warm. Then suddenly the dust was ejected from the funnel by releasing the pinch cock that held back the compressed air in the ½-gallon bottle. The dust coming in contact with the heated coil was ignited, the resulting explosion being evidenced by a flame in the bottle, a comparatively loud report, and the complete smashing of all the glass parts of the apparatus. A drawing of the above apparatus and a description of the experiment will appear in a forthcoming bulletin on the inflammability of coal dust. This experiment was devised under the direction of J. C. W. Frazer, chemist, and was conducted by E. J. Hoffman, assistant chemist and Louis A. Scholl, jr., junior chemist.

SAFETY LAMPS.

During the forenoon of October 30, in building No. 17, there was a continuous series of tests (No. 17 on the program) with single and double gauze safety lamps in a current of air of varying velocity and containing 8 per cent explosive gas (methane and ethane). The results of these tests showed that in the gallery a single-gauze Davy lamp ignited the gas-and-air mixture in 10 to 18 seconds at a velocity of 600 feet per minute. The double-gauze bonneted lamps, in a current of explosive air and gas moving at a velocity of 2,500 feet per minute, caused no explosion within the gallery.

The tests were made in horizontal currents. The gallery used for making these tests is 20 feet long, 12 inches high, and 6 inches wide, and is provided with heavy glass windows and explosion relief diaphragms. The velocity of the current through the gallery is regulated by a pressure fan.

BREATHING APPARATUS.

During the forenoon of October 30, miners trained in the use of artificial breathing apparatus gave an exhibition (event No. 18) within a gas-tight room, in building 17, filled with irritating and irrespirable smoke and gases. This room is used for training miners in the use of the various types of breathing apparatus for entering mines after explosions or mine fires. The equipment within the gas-tight room is intended to simulate some of the physical conditions found in mines after explosions.

MINE-SAFETY CARS AND STATIONS.

During the demonstration there were on view three mine-safety cars, one from the State of Illinois, one belonging to the American National Red Cross, and one belonging to the Bureau of Mines. On each car there were demonstrators who explained the purpose and the equipment of the cars.

Early in the investigation of mine disasters it was necessary to provide, in the important coal fields, facilities for enabling engineers to examine mines after disasters, while the mines were still full of poisonous explosive gases, in order that examination might be made while the evidences of a disaster were still fresh. It was found also that such prompt examinations would be useful in opening up these mines and in rescuing miners who might be entombed. Consequently, in those of the larger coal fields in which mine disasters are most likely, the Bureau of Mines established mine-safety stations or mine-safety cars. The first of the stations was established at Urbana, Ill., in 1908; a second at Knoxville, Tenn., in 1909; and a third at Seattle, Wash., in 1909. A fourth station at McAlester, Okla., in 1910, and a fifth at Birmingham, Ala., in 1911, were subsequently established, these with the Pittsburgh station making six stations suitably equipped.

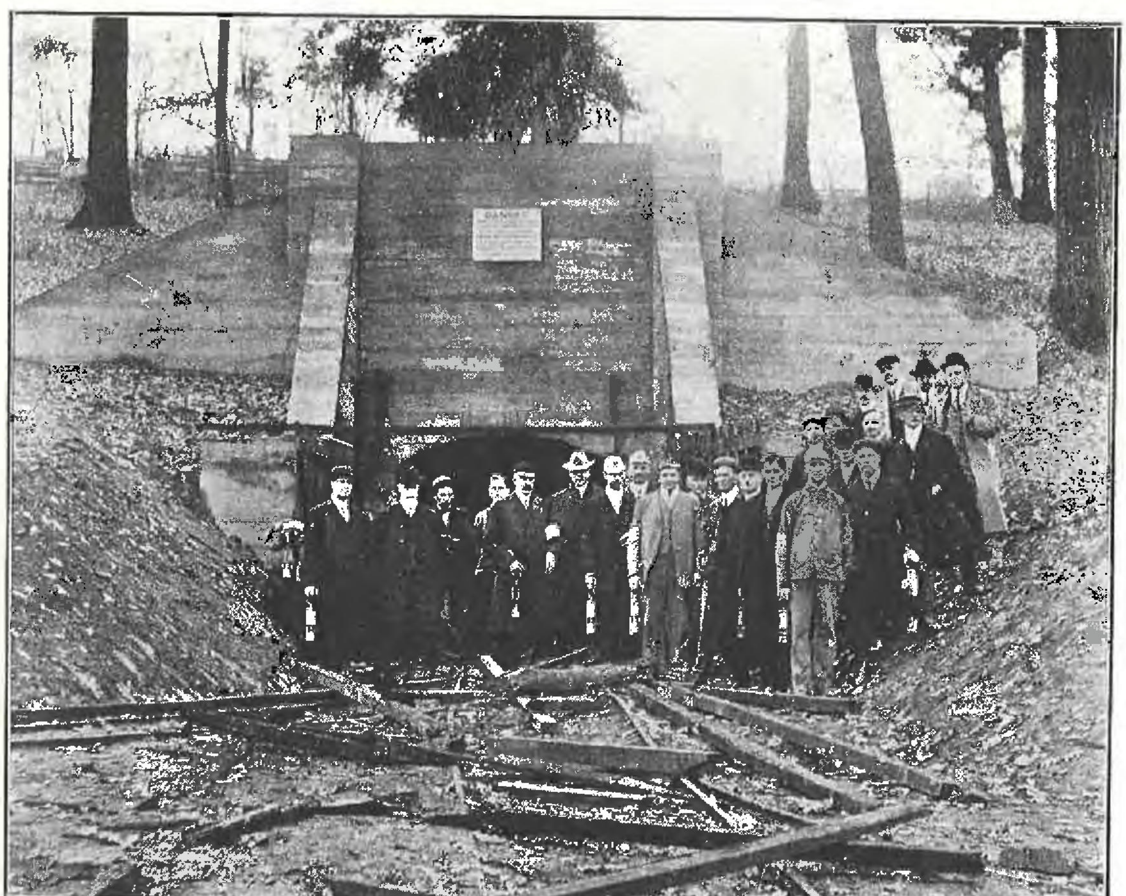
Seven mine-safety cars are operated by the bureau. They were purchased as second-hand cars, refitted at a cost of about $1,500 each, and equipped at a cost of about $3,500 each. Plate I, *A*, shows the interior of one of the mine-safety cars. These cars are distributed as follows: Car No. 1, in the anthracite coal fields of Pennsylvania; car No. 2, in the coal fields of New Mexico, Colorado, Utah, and southern Wyoming; car No. 3, in the coal fields of western Kentucky, Indiana, and Illinois; car No. 4, in the coal fields of Iowa, Kansas, Missouri, Arkansas, and Oklahoma; car No. 5, in the coal fields of northern Wyoming, Montana, and Washington; car No. 6, in the coal fields of Ohio, central and western Pennsylvania, northern West Virginia, and Maryland; car No. 7, in the coal fields of southern West Virginia, western Virginia, eastern Kentucky, eastern Tennessee, and Alabama.

The foremen of these cars train miners in first-aid and rescue work and give instructions concerning mine safety. A car moves from one mining camp to another. When a serious mine disaster occurs in any district the foreman in charge communicates with the mine operator and, if necessary, has the car taken immediately to the scene of the disaster; a special locomotive or the first available train is utilized. The foreman, or the mining engineer of the bureau in charge, at once offers to the local State inspector and to the mine operator any assistance or cooperation they may desire. Usually the force on the car, together with such local miners as have had rescue training, make an examination of the mine, penetrating its poisonous and explosive gases with the aid of artificial breathing apparatus. They then aid in the rescue of any persons who may have been entombed.

The primary purpose of the cars and stations is not the rescue work that they may incidentally accomplish, but the investigation of mine disasters, the development of more efficient mine-safety and first-aid equipment and methods, and the training of local miners at each of the mining camps visited, so that in case of mine accidents of any kind there will be at each mine men ready and equipped to render immediate and valuable assistance. To carry out these purposes the mining engineer of the bureau examines in advance the safety conditions at mines, advises with the mine officials concerning the possibilities of improving these, and delivers illustrated lectures to miners, calling attention to the need of greater care in safeguarding their own lives and the lives of others. Daily demonstrations of mine-rescue and first-aid equipment and methods are given. Miners are trained in methods of handling such equipment under mine-disaster conditions.

This part of the bureau's work is under the direction of J. W. Paul, mining engineer, in charge of the following: J. C. Roberts and H. M. Wolflin, mining engineers; O. H. Reinholt and J. T. Ryan, assistant mining engineers; C. S. Stevenson, W. D. Roberts, J. M. Webb, E. B. Sutton, W. T. Burgess, A. R. Brown, D. D. Davis, A. A. Sams, W. A. Raudenbush, and William Burke, foremen miners; W. D. Schofield, G. T. Powell, C. O. Roberts, and John Ferrell, first-aid miners.

A. INTERIOR OF BUREAU OF MINES MINE-SAFETY CAR.



COAL-DUST EXPLOSION AT EXPERIMENTAL MINE.

By George S. Rice.

SELECTION OF MINE.

Soon after the investigation of the causes of mine explosions was authorized by Congress in 1908 the technologic branch of the United States Geological Survey, under whose charge it was placed, gave consideration to the establishment of an experimental mine where coal-dust tests could be made on a larger scale than was possible in a surface gallery. In 1910, when the mine-accidents work was transferred to the newly established Bureau of Mines, an allotment was made to establish an experimental mine. Attempts were made to find an abandoned mine which would be suitable, but none such was found. Following this, efforts were made to find a suitable location for opening a new mine. As the Pittsburg coal bed is one in which many serious disasters have occurred, it was thought best that the mine should be opened in this bed. Another consideration was that the mine must be isolated and in such a location that the concussive air waves started by an explosion would be deflected upwards, thus reducing the chance of shattering windowpanes in distant houses, a difficulty experienced at the English and the French dust-explosion stations.

It was also necessary that the mine should not produce a perceptible amount of methane so that coal-dust tests could be carried on without the complication of mine gas. On the other hand, it was important that natural gas be available for introduction through pipes into the mine for gas-explosion experiments and for combined gas and coal-dust tests.

It was also important that the mine be naturally dry so that experiments with dry coal dust would be possible. Complications and difficulties connected with shaft linings precluded a shaft mine, so that a mine on the outcrop was considered essential. The Bruceton location, which was finally selected, was one of the few available places that met all the requirements. The entries were started in December, 1910, and the work of development and of erecting the plant proceeded as rapidly as circumstances would allow.

LAYOUT OF MINE.

The mine consists of a pair of entries driven in the Pittsburg bed. These entries are nearly parallel with the "butt" joints of the coal and at right angles to the "faces"; in other words, the entries are what are termed "face" headings. The coal bed rises on a slight grade from the outcrop. A plan of the mine workings is shown in figure 2, and the mouth of the entries at the outcrop is shown in Plate I, *B*.

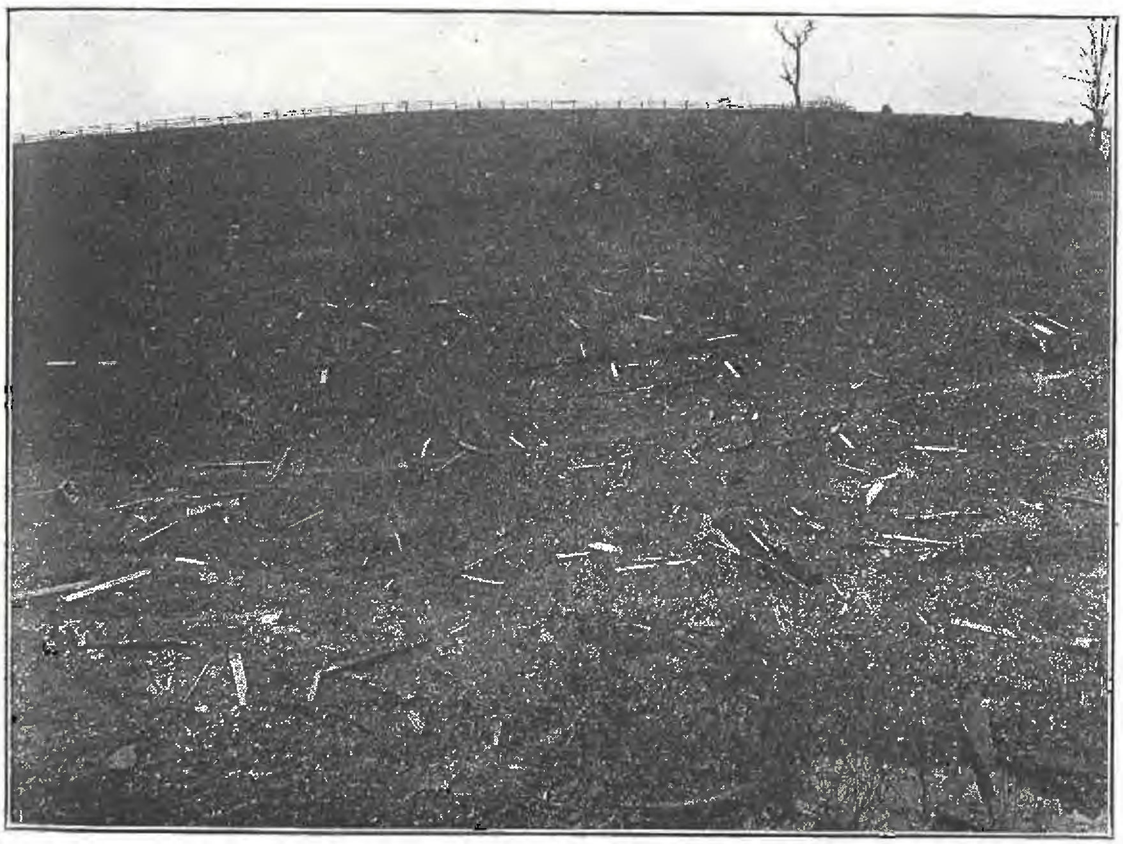
At the time of the experimental explosion of October 30, 1911, the main entry was 713 feet long and the airway 669 feet long, with three crosscuts between them. The entries extend in a southerly direction. The west one is called the main entry and is the chief explosion passage. The east entry is the airway. There is a small shaft on the east side of this entry, 62 feet from the mouth, for ventilation when driving entries.

A third passage, 198 feet long, enters the airway from the east at an angle of 55°. At the outer end there is a concrete section 20 feet long, covered with boards or plates weighted with sand bags, which serves as a large relief valve. Beyond this, and in line with it, there is a steel gallery (just back of two trees on right of foreground of Pl. II, *A*) 122 feet long, of which 20 feet at the mine end can be rolled to one side so that special experiments can be made in the isolated 102-foot section. This is nearly a duplicate of the gas and dust gallery at the Pittsburg station, except that the outer end is closed with a wooden stopping, and near this end there is a Y for fan connection. The installation of a powerful fan for making coal-dust experiments in high-velocity air currents is intended. This fan, which is now on hand, is reversible and has a rated capacity of 80,000 cubic feet of air per minute with a 2-inch water gage, and of 15,000 cubic feet of air per minute with a 6-inch water gage.

At the time of the test, on October 30, a small fan (capacity, 10,000 cubic feet per minute with a 1-inch water gage) driven by a gas engine was installed in an offset off the Y, near where the permanent fan will be erected. This small fan is for future use at the top of the air shaft, to act as an auxiliary fan for ventilating the mine when the large fan is not employed or is cut out by breakage resulting from an explosion.

The steel gallery is 6 feet 4 inches in diameter. The oblique heading between the external gallery and the airway is lined with reinforced concrete and is 6 feet 4 inches wide by 6 feet 4 inches high. The main entries are each 9 feet wide and from 6 to 7 feet high. The outer 169 feet of the main or explosion entry is lined with reinforced concrete; the internal dimensions are 8 feet wide and 7 feet 6 inches high. The airway at the junction of the slant or gallery entry and for a distance of 20 feet outby and 65 feet inby is similarly

A. VIEW OF SIDE HILL, SHOWING GALLERY ENTRANCE IN CENTER AND MAIN ENTRANCE IN BACKGROUND.



B. SIDE HILL OPPOSITE MINE, SHOWING CAR AND OTHER DÉBRIS THROWN BY THE EXPLOSION.

lined. At the junction the reinforcement, of $\frac{3}{4}$-inch square-rod arches and $\frac{1}{4}$-inch longitudinal rods, is supplemented by steel rails. Ordinary mine-car tracks are in each of the entries.

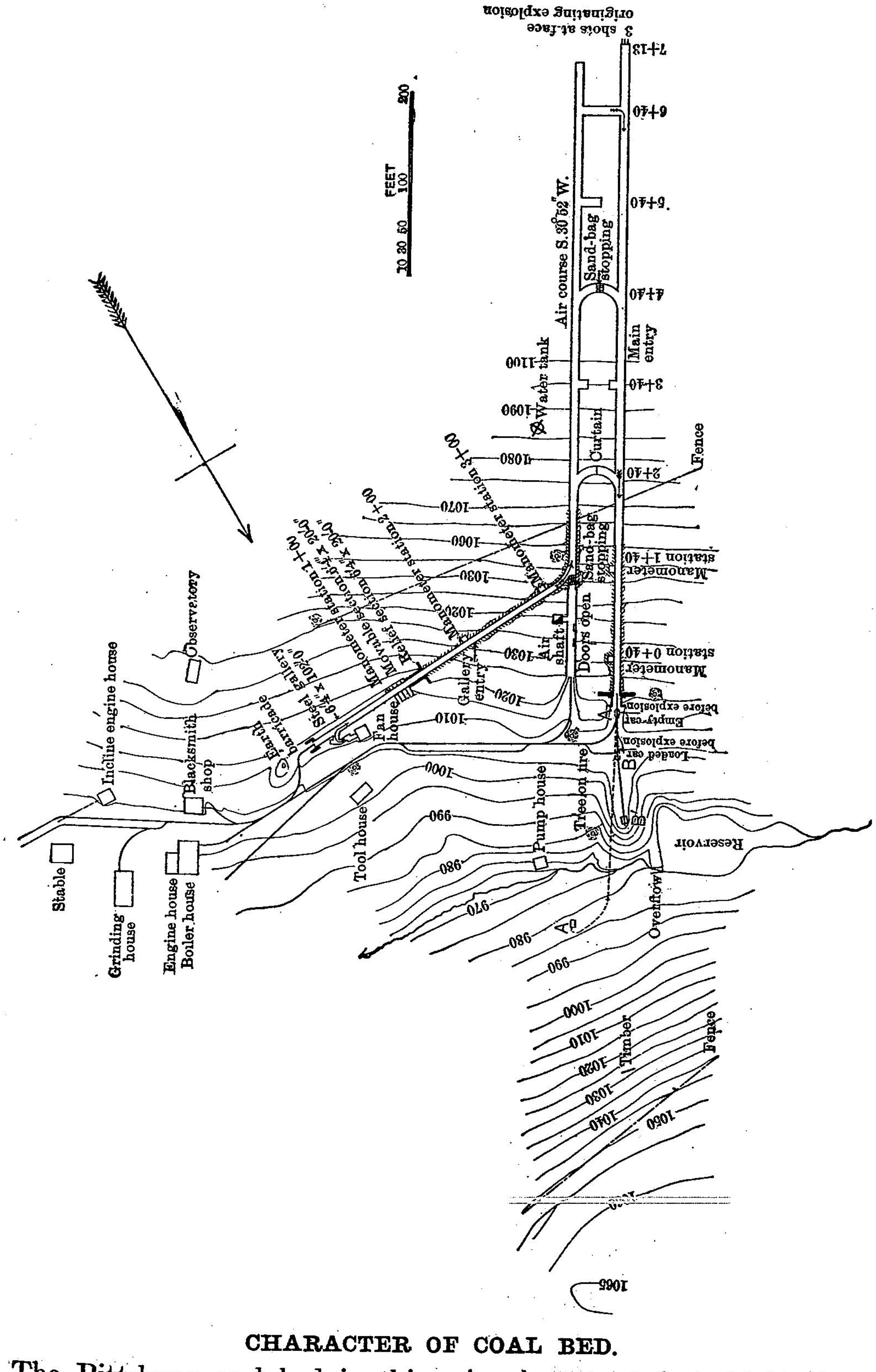


FIGURE 2.—Plan of experimental mine.

CHARACTER OF COAL BED.

The Pittsburg coal bed in this mine is 5 to 6 feet thick, above which there is a "draw slate" 6 inches to 2 feet thick. In places this "draw slate" contains many slips and has to be taken down.

Above the "draw slate" there is in places a top coal 1 to 2 feet thick, but more or less shaly. The next stratum above is shale. These are the normal conditions for the Pittsburg bed in the vicinity of the mine. The coal bed proper is free from continuous partings, except two small bands of shale 3 inches apart. The upper band is one-eighth to three-fourths inch thick, and the lower is one-fourth to one and one-fourth inches thick. These bands are a little below the middle of the bed. The faces and butts are strongly marked. The coal is somewhat soft, and in the process of mining a large proportion of finely broken coal is formed.

The average proximate analysis of the coal from three full-section face samples is as follows:

Analysis of coal from experimental mine.

Moisture	2.73
Volatile matter	36.03
Fixed carbon	54.98
Ash	6.26
	100.00
Sulphur	1.39

The dust used in the experiment of October 30 was not made by grinding the coal of this mine, as will be done in future experiments, but was made from coal from a mine in the Pittsburg bed, which has furnished the so-called standard dust of the Pittsburgh experiment station. Samples of the dust used showed that 98 per cent passed through a 100-mesh sieve. Its proximate analysis is as follows:

Analysis of coal dust.

Moisture	1.94
Volatile matter	35.11
Fixed carbon	57.73
Ash	5.22
	100.00
Sulphur	1.25

DISTRIBUTION OF THE COAL DUST.

As the floor of the entry is the natural floor with a ballasted track, it is not smoother than ordinary mine roadways. To save difficult cleaning, the old burned and unburned dust on the roadway is wet down or covered with damp clay. The fresh coal dust is placed on shelving which can be easily cleaned after each experiment. The permanent shelving will consist of 3 by 4 inch lumber, bolted along the concrete sections and, in the unlined coal sections, fastened to recessed props. The lumber is placed with the 3-inch face upwards so as to provide a 3-inch shelf. There will be five lines on either side (see fig. 3). This was essentially the arrangement on October 30, except that the shelving had been merely wired to the bolts in the concrete-lined area and in the unlined area had been fastened to temporary props. At a few points, as in the first crosscut, where the regular shelves had not been placed, some special cross shelves were used. No dust was used in the air course inby this crosscut. The

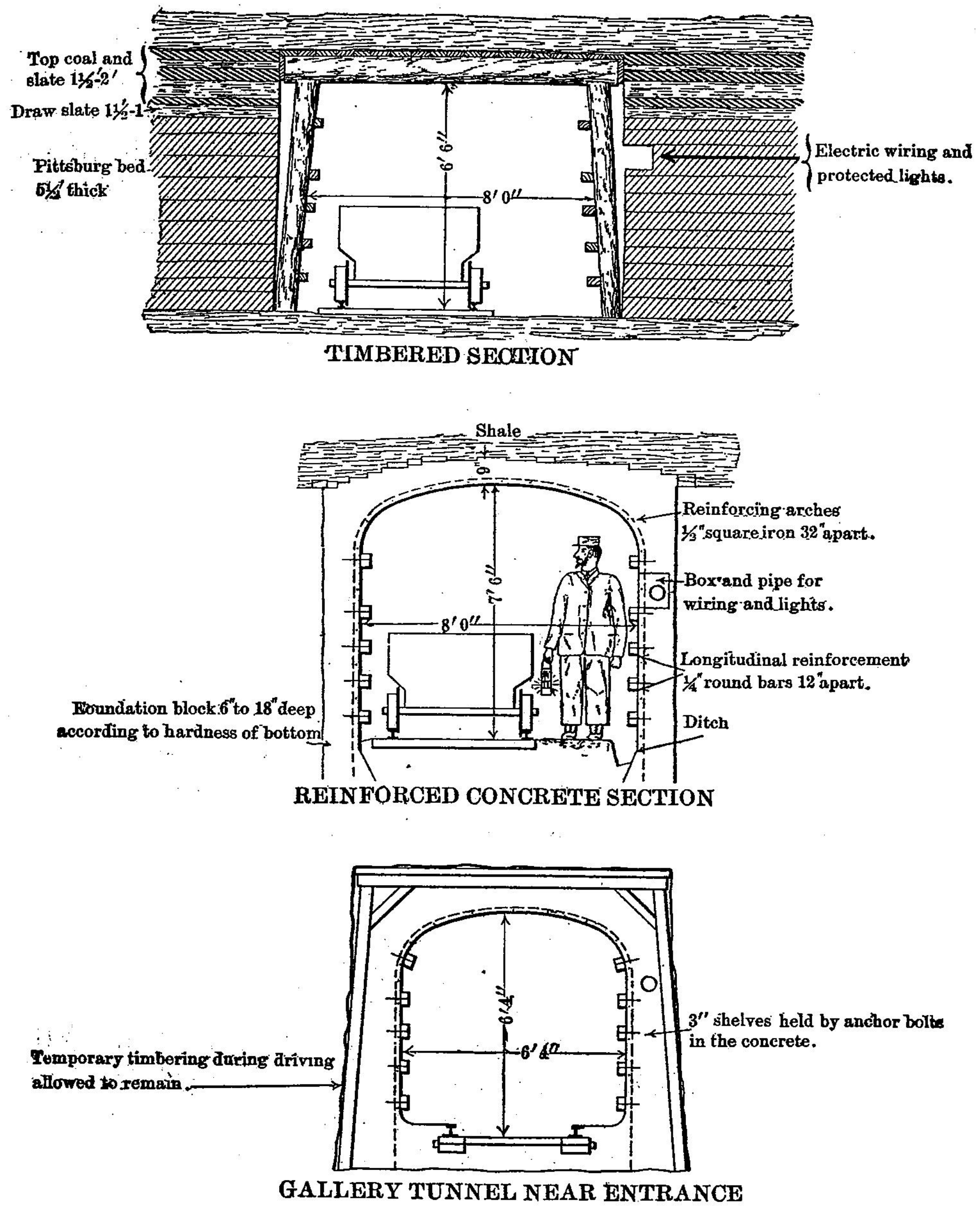


FIGURE 3.—Cross-sectional views of mine gallery, showing dust shelves.

air course outby the gallery junction was cut off by a heavy sand-bag stopping. In the main entry, 627 pounds of dust, equal to 0.88 pound per linear foot of entry, was placed on the shelving. The outby crosscut from the main entry to the airway, thence on this to the gallery entry and out the latter to and through the steel gallery, a total distance of 481 feet, was loaded with dust to the amount of 0.46

pound per linear foot, a total of 225 pounds of coal dust on that side. The entire quantity used in the explosion was, therefore, 852 pounds.

INSTRUMENT STATIONS.

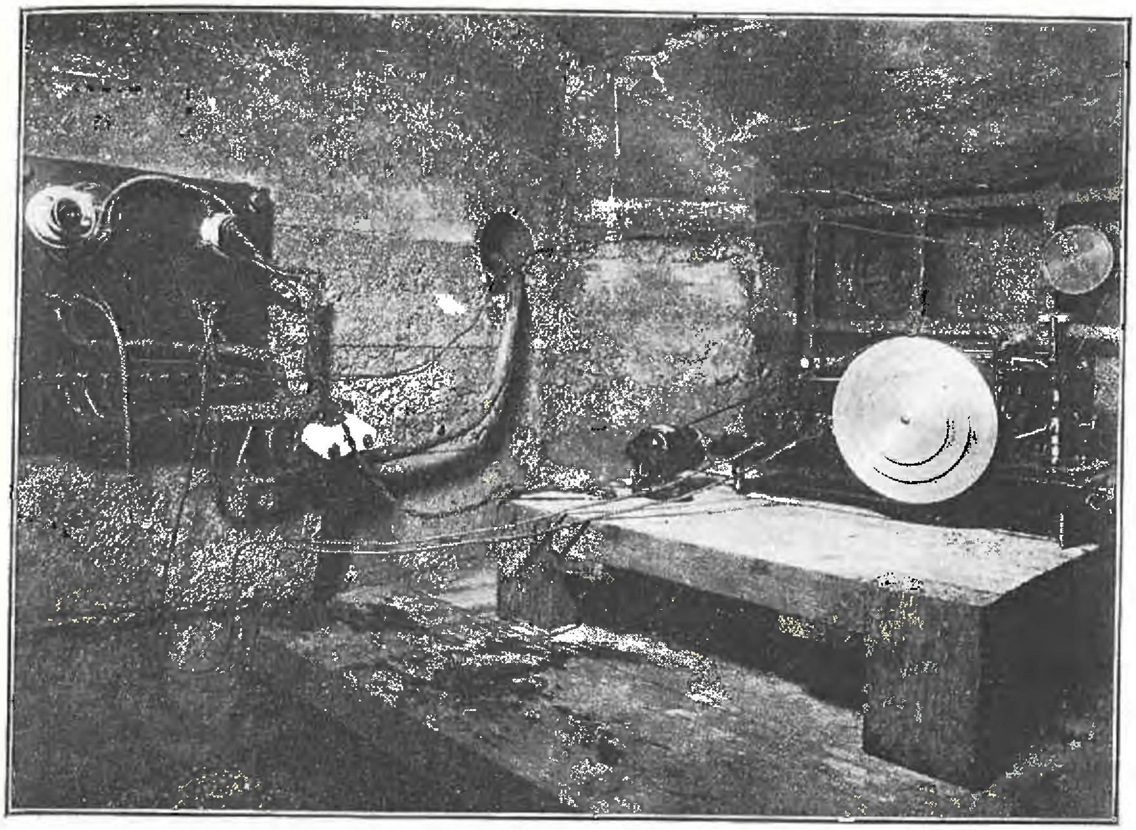
At the time of the test five instrument stations had been constructed—one attached to the external gallery, two in the gallery entry, and two in the main entry. These stations were erected for safely housing the recording manometers used to obtain pressure curves. They were also designed to house circuit breakers (both pressure and flame) for respective velocity records and automatic gas-sampling devices. The four mine stations are built in the rib and are lined with reinforced concrete. In the entry side there is a heavy-ribbed cast-steel plate, through which connections are made to the instruments (Pl. III, *A*). Entrance behind the instruments is obtained through an adjoining compartment, the doorway of which to the entry is guarded by a ribbed cast-steel door. The cast-steel cover and door are made to resist pressures of 600 pounds per square inch. The plate is permanently bolted in place and the door, after closing, is made tight by iron wedges.

The equipment at present includes circuit breakers and three manometers of the Altofts type. At the time of the experiment, only two manometers and two pressure circuit breakers could be used. The two manometers were placed in the main entry stations at 40 and 140 feet, respectively, from the mouth of the entry. The circuit breakers were also placed in these stations, and a small wire was placed where the first blown-out shot could break it and thus indicate the start of the explosion. The velocity records are automatically registered by instruments in the observatory on the hillside, from which point the shots are ignited by battery.

IGNITING SHOTS.

It had been planned that the persons who would see the exhibit would go to the mine by train, arriving about 2.30 p. m. After the mine had been examined, the test was to be made at about 3.45 p. m. Unfortunatdly, the train was delayed about an hour, so that the inspection of the mine by the 1,200 visitors was not completed until after 5 o'clock.

The intention was to ignite the coal dust by a single blown-out shot placed at the face of the main heading, as had been successfully done in a similar experiment on October 24. Two auxiliary holes, one on either rib, had been drilled for a second firing circuit in case of failure of the first shot. In the trial explosion of October 24, a single blown-out shot, charged with two pounds of black powder, started the explosion.



A. INTERIOR OF AN INSTRUMENT STATION, SHOWING MANOMETER AND PRESSURE CIRCUIT BREAKER.

To cause each shot to blow out, there was drilled in the face a hole sufficiently large to receive a 1½-inch iron pipe, about 3 feet long, with an iron plug at the inner end. Some clay was tamped against the plug, and common black blasting powder was next inserted, with an electric detonator near the outer end. The charge was tamped hard with 4 inches of clay. The charged pipes were then placed in the respective holes so that the end of each pipe was flush with the mouth of the hole. Each hole was bored straight into the face, at 2 feet 10 inches above the floor.

The electric wires and lights which enabled the visitors to inspect the mine were removed, the shots prepared, and electric connections made. Tests of the firing lines, earlier in the day, had shown the lines intact. The lines, consisting of two separate circuits, in addition to a third circuit for velocity records, entered the mine in pipes placed behind the concrete lining. Beyond the lining the permanent arrangements had not been made, so the wires were laid in one corner of the air course, thence through the last crosscut to the face of the main entry.

On the first two trials the first shot, and later the second shot, failed to go off, owing to short circuits. It seems probable that the wires had been trampled upon and the insulation injured. Then an entirely new set of firing wires was brought into the mine and laid through the air course and last crosscut to the shots in the main heading. In view of previous mishaps, all shots were connected in parallel. When this arrangement was tried the ignition and the explosion followed at about 6.15 p. m.

In all 9¼ pounds of black powder was discharged in the shots on October 30. So far as the records showed, the effect on the inner part of the mine was no greater than on October 24, when a similar coal-dust explosion was started by a single shot with 2 pounds of black powder. Subsequent examination showed that the shots had all gone off, and each was essentially a blown-out shot; the pipe in each case had ruptured and the center shot had broken out some coal, making a crater about 18 inches deep (Pl. IV, *A*).

EFFECT OF THE EXPLOSION.

About one and one-half seconds after the circuit had been completed at the observatory, the explosion reached the open air. It burst forth with a roaring sound and vivid flames almost simultaneously from the several openings. The evening was rainy and dark, so that nothing but the sheets of flame could be observed. At the main entry the flame rose above the forest trees to a height variously estimated from 200 to 500 feet. Observers at the town of Library, 4 miles distant, saw the flames above the tops of the hills.

A limb of a tree was set on fire 153 feet from the mouth of the mine, and 46 feet above the level of the entry.

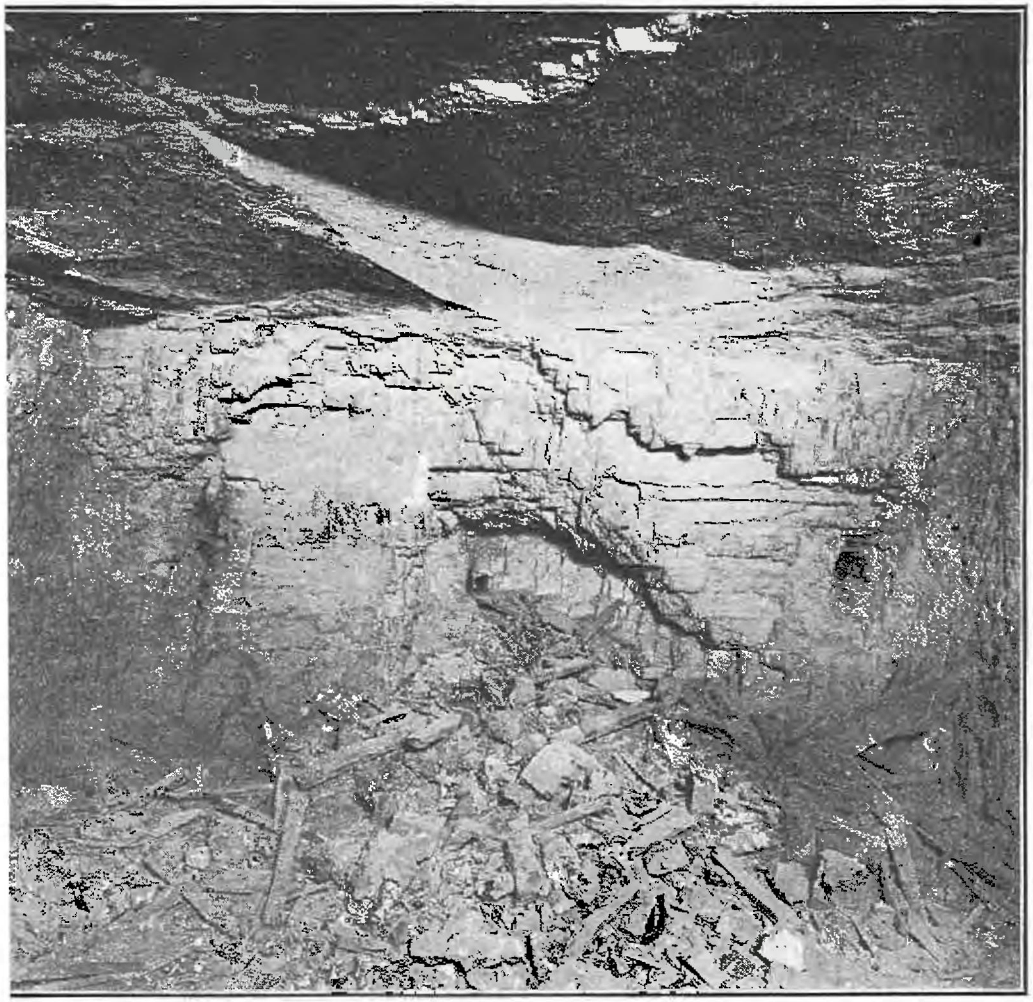
The sound of the explosion, while not sharp, carried a long distance. At Library windows were rattled. The explosion was heard at Carrick, 5 miles to the north, and at Monongahela City, 12 miles to the south.

A mine car containing several hundred pounds of gravel stood on a switch outside of the mine in line with the main entry and 40 feet from the mouth. Twenty-five feet beyond it there was a car loaded with $1\frac{1}{4}$ tons of coal. The gravel car, weighing about 2,000 pounds, was thrown over the top of the coal car, and landed 184 feet away on the opposite slope of the ravine that passes the foot of the dirt dump. It then bounded four times and landed 45 feet from where it first struck, making the total distance moved 229 feet (see Pl. II, *B*, and A–A′, fig. 2).

The loaded car, with the brakes set, was thrown along the track and derailed at the end of the dirt dump, 70 feet from where it had been standing (see B–B′, fig. 2). Pieces of timber were scattered over the hillside opposite, some of them higher than the level of the mine and nearly to the top of the hill. A 3 by 4 inch timber was thrown 413 feet from the mouth of the mine and landed on ground 18 feet higher. The flame that issued from the main entry was sustained for several seconds, so long that at distant points many persons whose attention was attracted by the sound were able to turn around and see the flame.

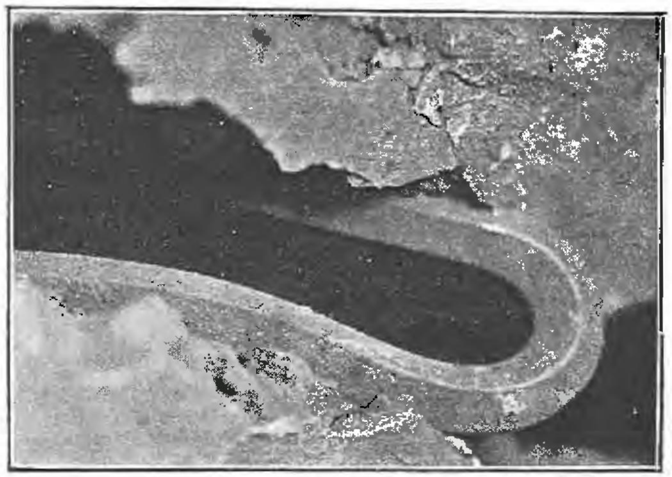
Sheets of flame burst out of all the doors in the steel gallery. The 20-foot relief valve at the mouth of the gallery entrance was thrown high in the air. It consisted of boards weighted with sand bags. The timber stopping closing the outer end of the gallery was blown out and broken into small fragments. The wooden casing and the connection to the fan, in spite of the relief valves and doors, were blown apart. Two windows in a near-by tool house were blown outward toward the gallery, presumably from the suction following the explosion. The heavy sandbag stopping, 6 to 8 feet thick, across the air course at the junction with the slant, was blown outward and the sandbags scattered to a point 50 feet outside the mine. Some of the bags of this stopping, by the inward reflex wave, were thrown 5 to 10 feet inby from their original position.

Owing to the wreckage of the fan casing and connection, ventilation could not be immediately restored, although a natural ventilation was established through the air shaft acting as an upcast. The repairs on the fan were made during the night and brattices erected in the crosscuts so that an inspection of the mine could be made on the following day.



A. SHOT HOLES, AT FACE OF MAIN ENTRY, WHICH CAUSED EXPLOSION; WOOD FRAGMENTS DRAWN INTO CENTRAL CRATER.

B. BLISTERED COAL IN MAIN GALLERY.



C. BENT ⅝-INCH STEEL BAR, SHOWING LIFT OF ROOF.

EVIDENCE OF EXPLOSION IN THE MINE.

At the face of the main entry, where the shots were fired, it was found that fragments of some boards that had been laid on the floor to receive the coal dust had been drawn back into the crater made by the center shot (Pl. IV, *A*). This was due presumably to the gases rushing back to fill the vacuum caused by the blast. There was no evidence of great violence, except in the immediate vicinity of the shots, until the middle crosscut was reached.

SOOT FILAMENTS.

Between the face and the open crosscut 70 feet from the face there were threads of soot hanging from the roof and ribs (Pl. V, *A*). Evidently the threads or filaments came from the excess of carbonaceous matter in the atmosphere during the explosion, as they are frequently observed in quiet areas of mines in which explosions have occurred.

COKED DUST.

Although no dust had been placed along the inner crosscut, the flame from the main entry had branched through it, and thence into and outward along the air course. Crusts of coke were plastered on the rib near the roof at the inby corner of the air course and the crosscut (Pl. V, *B*). There was a small quantity of coked dust on a prop which stood at this corner.

Little trace of the explosion was found toward the face of the air course. Unused cross shelves were only slightly moved, and buckets, containing coal dust, standing at the face had not been disturbed. There were deposits of coke and coked dust on the west rib of the air course for 28 feet inby the last crosscut and for 14 feet outby. Smaller deposits were found on the east rib throughout this distance.

There was little coked dust in the main entry. The coke was found only as small isolated particles in the inner part of the entry and none at all was observed toward the outer end. The absence of a considerable amount of coked dust may be attributed to three causes: (1) There was practically no coarse dust, 98 per cent passing through a 100-mesh sieve, so that the dust which entered into the explosion was probably largely consumed, leaving only ash. (2) The violent movement of the gases along the main entry probably carried away what little coke might have been formed in that entry. (3) The roof and ribs were damp, and it has been observed in other mine explosions that coked dust does not tend to stick to a damp surface and that a relatively slow air movement, such as a reflex wave would give, is likely to sweep away detached particles.

EFFECT OF FLAME ON COAL RIBS.

In several places along the inner crosscut and along the air course outby the inner crosscut the ribs showed marked signs of blistering. The soot, which elsewhere coated everything, was absent in these places and evidently thin scales of coal had dropped off after the explosion, leaving rounded surfaces instead of the usual flat facings with square edges. (Pl. IV, *B*.)

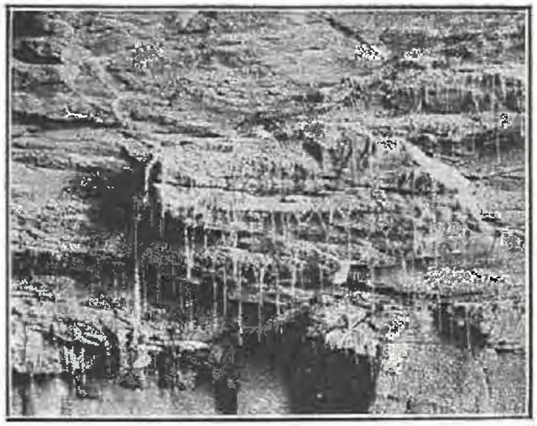
VENTILATION.

The regular ventilation was carried on at the time of the explosion. There was about 9,000 cubic feet of air per minute entering the mine through the gallery and about 8,000 cubic feet passing through the open crosscut at the 640-foot station and returning in the main entry. The shots were, therefore, fired in a dead end, but the explosion encountered moving air at the first crosscut. The second crosscut contained a sandbag stopping 7 feet thick. The bulk of this stopping was blown toward the air course, but a considerable number of the bags had been thrown toward and into the main entry. It would appear that the first explosive wave coming out the main entry had overturned the stopping toward the air course and that the branch explosion coming out that passage a moment later had thrown a number of the loose bags back toward the main entry.

In the outer crosscut, there was only a canvas curtain stretched across to keep the air current from short-circuiting. The crosscut was loaded with 0.46 pound of coal dust per linear foot placed on temporary shelves. That branch of the explosion passing through this crosscut did not appear to have been violent, as light cross timbers placed in the air course just outby the crosscut had not been disturbed, although they had some burned dust sticking to them, and fragments of a curtain were slightly burned. Immediately beyond these timbers in the air course, the explosion appears to have suddenly increased in violence. Whether the increase of violence was due to enlargement of air space at the junction with the slant entry or to other cause is uncertain at this time. All the heavy shelves beyond this point were thrown down and some of them broken. The sandbag stopping across the air course was thrown outby, some of the bags going outside the mine, although a few bags were drawn inby, seemingly by the reflex air wave.

CONCRETE LINING BROKEN.

As in the explosion on October 24, the concrete arching was lifted. The concrete corner of the Y was broken by a horizontal fracture and the upper half lifted so that a stick and pieces of a curtain brattice



A. FILAMENTS OF SOOT NEAR THE FACE OF THE MAIN ENTRY.

C. REINFORCING ROD PULLED OUT OF CONCRETE IN MAIN GALLERY.

B. COKE CRUSTS AT THE INBY CORNER OF THE CROSSCUT AND AIR COURSE.

were blown into the opening and held fast when the concrete settled back to its normal position (Pl. III, *B*).

OTHER EFFECTS OF EXPLOSION.

From the junction to the mouth of the concrete gallery there were continuous cracks along both springing lines of the arch, and at a point 22½ feet from the mouth of this slant entry the lift was at least 12 inches, as shown by one of the ⅝-inch reinforcing rods pulling out and subsequently doubling as the roof dropped back in place. (Pl. IV, *C*.) Other rods in this vicinity were pulled through the concrete. (Pl. V, *C*.) No upheaval due to the explosion was readily discernible on the surface, except where there had been a filling near the mouth of the gallery, where the cover was only 8 feet thick. This point was directly above the place where the concrete roof was lifted 12 inches.

The explosion rapidly increased in violence after passing the outby crosscut in the main entry, 470 feet from the origin of the explosion. Farther out the pressure lifted the reinforced concrete arching, breaking the concrete around the bars. At a point 50 feet from the mouth the arch was lifted and remained 11 inches above its former position. (Pl. VI, *A*.) There had been a roof fall at this point prior to putting in the concrete lining, and dry material had been packed into the hole. Cement subsequently pumped behind the lining may or may not have permeated the dry packing. Thus there may have been sufficient voids to permit some or all of the lift noted. The natural cover was 12 feet thick where the maximum displacement occurred. The cover did not show any break on the surface.

The effect of the explosion at the mouth of the main entry is shown in Plate I, *B*. The pieces of timber in the foreground are the shelves that were blown out of the mine at the time of the explosion. This illustration also shows the concrete construction at the mouth of the entry, which was heavily reinforced. The reinforcing bars of the concrete arch and sides of the entry are five-eighths inch square, which, together with ¼-inch round rods placed longitudinally, form a complete network of steel. This construction extends the entire length of the concreted portion of the entry.

INSTRUMENT RECORDS.

Unfortunately the circuit for the manometers had not been repaired at the time the new firing wires were brought in, so that the only records obtained were those for maximum pressure. The springs furnished with the instruments were for use up to a pressure of 30 pounds per square inch. The manometer at station 140 (140 feet from the portal) showed that the pressure was above 45 pounds,

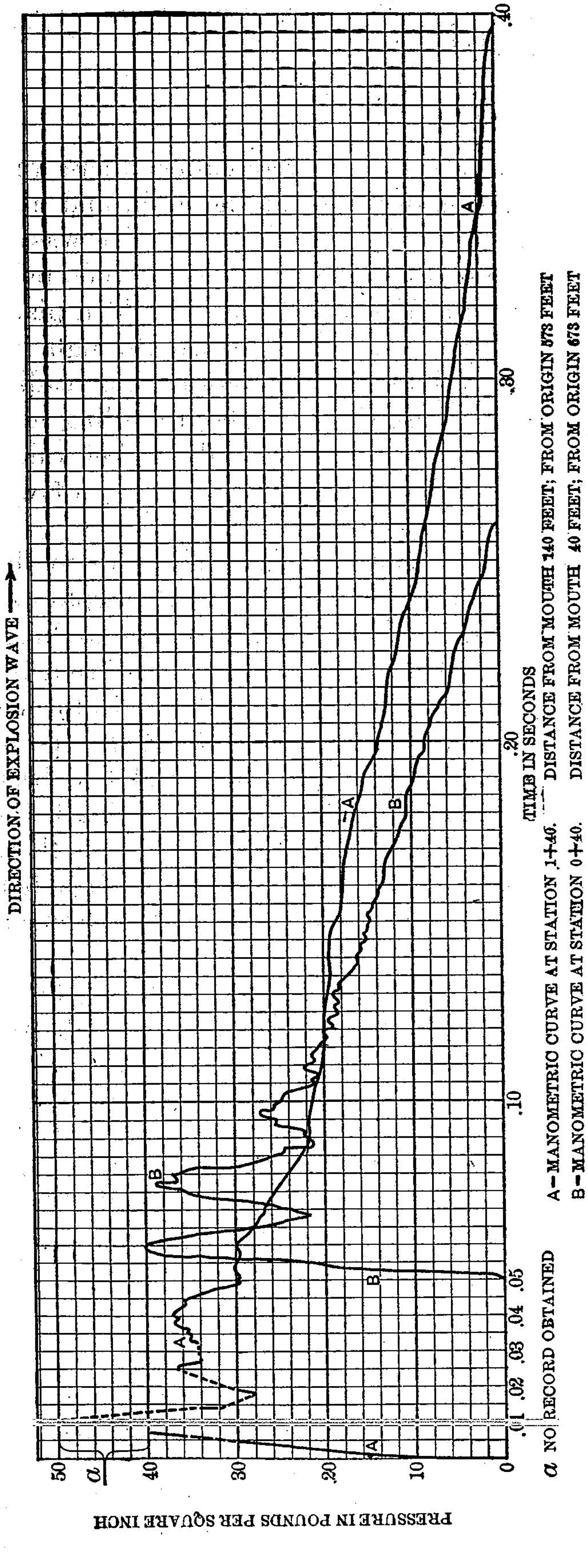
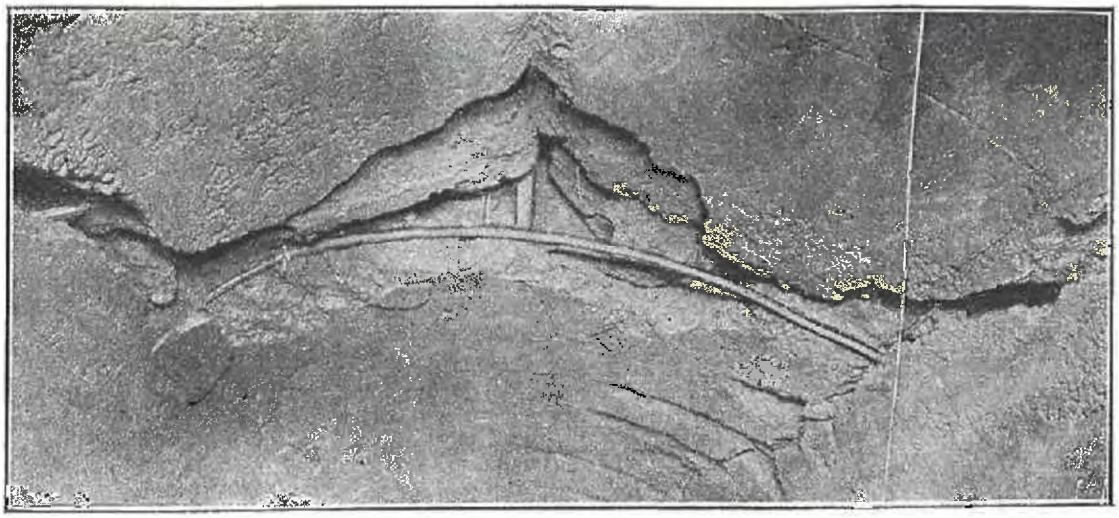


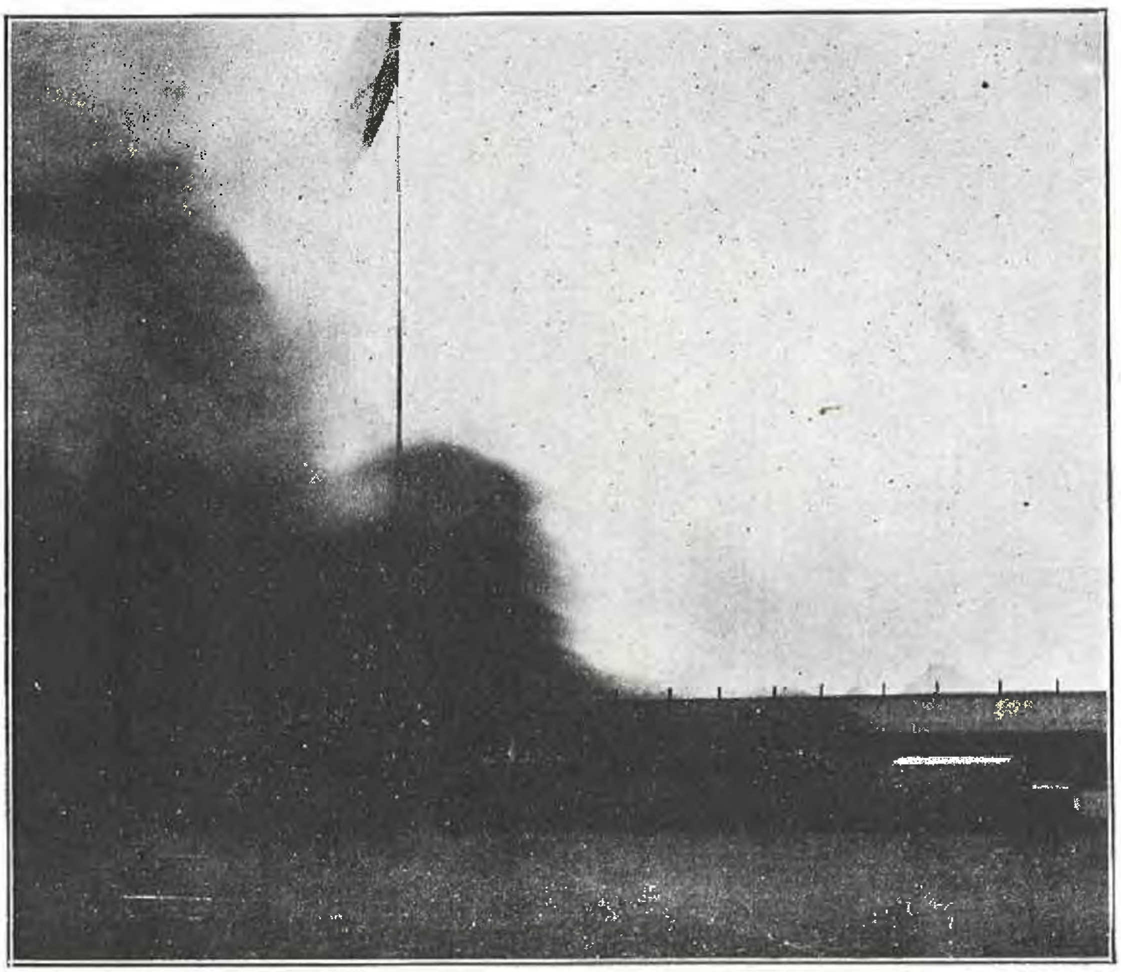
FIGURE 4.—Pressure curves obtained in coal-dust explosion on October 24, 1911, in experimental mine.

but how much higher is not known. The instrument at station 40 indicated a pressure of 44.8 pounds.

The actual pressure may be inferred from the records obtained on October 24, when the conditions were similar to those on October 30, except that only 500 pounds of coal dust was used in the main entry, and the outer 300 feet was not charged with coal dust. It is probable that there was nearly sufficient coal dust carried along by the advance wave to obtain approximately parallel records. A diagram showing the curves obtained by the two manometers is given in figure 4; both curves are platted with reference to the same time intervals. The circuit breakers showed that the explosion traversed the entry from the face to station 140 (573 feet) in 1.52 seconds, and between that and the next station (100 feet) in 0.0513



A. RUPTURE IN ROOF OF MAIN GALLERY, EXPERIMENTAL MINE.



B. COAL-DUST EXPLOSION IN STEEL GALLERY, FORBES FIELD.

second. Therefore, the average velocity of the first distance was 377 feet per second, and between the two stations was 1,948 feet per second. The latter velocity is greater than that reported in the first series of the Altofts experiments, though not so high as that reported in certain tests by Taffanel at the Liévin station.

It is the intention, when additional funds are allotted, to extend the main entry and air course and try more extensive explosions. When the wave movements of coal-dust explosions and the surrounding phenomena have become more thoroughly understood, the succeeding series of experiments will embrace tests of preventive means.

PERSONNEL.

The investigations at the experimental mine are in charge of G. S. Rice, chief mining engineer, assisted by L. M. Jones, mining engineer, and H. C. Howarth, mine foreman. J. K. Clement, physicist, assisted by W. L. Egy, assistant physicist, has charge of the velocity and pressure determinations.

FORBES FIELD EXHIBIT.

FIRST AID TO THE INJURED.

The idea of training men employed in hazardous professions in first aid to the injured dates from 1880, when the St. John's Ambulance Association was organized in England. Later the St. Andrew's Ambulance Association was organized in Scotland, and the Sameritter Verein in Germany, as well as similar organizations in France, Belgium, and Austria.

Membership in foreign first-aid organizations is permitted only after long and careful training. The work has been so dignified that the membership is considered a great honor.

First aid to the injured was not seriously considered in the United States until 1897, when several railroad companies furnished packets and books of instruction to some of their men. The work was started about 1899 in the anthracite coal fields, where it is now an essential feature of mining, one miner in every fifty having knowledge of the work.

The example set by the anthracite coal fields has been successfully followed in practically all mining States until at present any progressive mining company feels that its organization is not complete until the work of first aid to the injured is thoroughly established among its men. In 1910 the American National Red Cross organized a separate first-aid department, and at about the same time the Young Men's Christian Association made first aid a part of its educational work.

ENTRANCE RULES.

The demonstration of first aid to the injured by teams of trained miners representing mining companies from all sections of the United States took place at Forbes Field on the morning of October 31, 1911.

Preliminary rules were sent out on July 12, but on September 20 were supplemented by additional rules or suggestions thereon, making the final entrance rules as follows:

1. The national mine-safety demonstration will be a noncompetitive exhibition of skill in first aid to the injured in mines.
2. Not more than one team of five men shall represent any one coal mine, or the Bureau of Mines, or State mine departments, except that coal-mining companies operating more than one mine may enter additional teams representative of groups of miners, helpers, trapper boys, or other mine workers.
3. All persons entering shall submit certificates showing that they are, or have been, bona fide mine workers.

4. All entries shall close one month prior to date finally selected for the meet (Sept. 30, midnight).

5. Coal companies entering teams shall be invited to present, not later than one month in advance of the meet, viz, September 30, a list of five events as their choice, these to be submitted to the managers who will select five for adoption from the various events suggested, each entering team to exhibit in the events suggested by them, and such others of the five as they may elect.

6. Souvenir badges of the American National Red Cross, souvenir buttons of the Bureau of Mines, and souvenir programs will be presented to individual entrants; a souvenir first-aid box to each team entering; a souvenir pennant, with the name of the company sending entrant, to be presented to the company represented, and to be used on the field as a marker.

7. Each team will select its own subject in addition to the five operating members thereof, or will have a miner present, selected for them.

8. In this exhibition the correct use of the roller bandage or of the triangular bandage will be given the same credit. In dressing wounds, the first-aid packet only will be used. There will be no restrictions as to the make of the first-aid packet. Teams shall bring their own material, consisting of splints, cotton, bandages, first-aid packets, picric-acid gauze, tourniquets, stretchers, and at least two woolen blankets.

FIELD RULES AND EVENTS.

The following rules are those which governed the first-aid performances on the field:

1. The officers shall be as follows: A manager of events, a secretary and assistants, a field marshal and assistants, and a chief usher and assistants.

2. Each team may be identified by the number worn by the captain, the same corresponding to the number on the printed list of teams on the final program.

3. Each team shall perform according to the numbers assigned, all holding odd numbers performing together; subsequently, those holding even numbers together.

4. All patients must be placed on stretcher after each treatment. All artificial respiration must be given for one minute.

5. No practicing shall be permitted on the day of the demonstration, nor shall the patient assist in any treatment.

6. As soon as an event has been completed the team shall stand at position and the captain shall raise his hand.

7. The number of each event will be displayed, as performed, upon the bulletin board.

8. The beginning and closing of each event will be designated by the sounding of a gong. Two signals will be given for removal of bandages.

The demonstration of first aid to the injured was participated in by 40 teams, each consisting of five men and a patient, and representing mining companies from all sections of the United States, as listed in the following pages. In order that all the participants might benefit from the exhibit by their fellows, the teams performed alternately in two sections; the teams having even numbers performed together, and those having odd numbers together. The even-numbered teams performed the even-numbered events, and the odd-numbered teams performed the odd-numbered events, as listed below:

1. Treat a lacerated wound of the right side of head (temple) and a lacerated wound on top of the right shoulder; one-man event.
2. Treat a punctured wound over the left eye and lacerated wound of palm of right hand; one-man event.
3. Treat a simple fracture of left collar bone and simple fracture of jaw; two-men event.
4. Treat a dislocated right shoulder and simple fracture of right leg; two-men event.
5. Rescue and treat a man who has fallen on an electric wire, back down, clothing burning; rescue, extinguish fire, treat back and upper arms; team event.
6. Rescue and treat a man who has fallen on an electric wire, face down; rescue, extinguish fire, treat chest and upper arms; team event.
7. Treat gas burns of face, neck, ears, and hands; team event.
8. Treat gas burns of hands, right arm, and shoulder; team event.
9. Treat a broken back and simple fracture of right fore arm; team event.
10. Treat a dislocated hip and simple fracture of collar bone; team event.

Forty squares, each to be occupied by an exhibiting team, were numbered upon the ground in front of the grand stand, and 25 feet to the rear of these squares were placed the banners and numbers marking the positions of the various teams. In the performance of events 1, 3, 5, etc., teams bearing these odd numbers moved to the forward positions and performed. Immediately upon completion of the exhibit by all these teams, or at the expiration of the time limit, a gong was sounded, then all performing teams retired, each carrying its patient 25 feet to the rear, the even-numbered teams, 2, 4, 6, etc., advancing at the same time to the forward position and proceeding immediately to perform the even-numbered events. The time allotted for the completion of the events was one and one-half hours, but the teams completed the exhibition in 53 minutes. Plate VII, *A*, shows the Roslyn (Wash.) team, which is typical of the others.

In order to avoid confusion and to expedite action, five coaches were appointed as follows: Dr. M. J. Shields, in charge; J. J. Rutledge, R. Y. Williams, J. C. Roberts, and D. T. Dilts. Each coach looked after eight teams to see that they began treatment of the patients promptly upon the ringing of the gong, and commenced the removal of bandages from the patients in readiness for the succeeding event. In no instance did any team fail to complete the treatment within the time allotted. The spectators were kept informed of the number of the event in progress by display of the number on a bulletin board, this being supplemented by four announcers using megaphones. At the conclusion of the first-aid exhibition the teams withdrew from the field to a position immediately in front of the grand stand, where they remained at attention until the conclusion of the succeeding events on the program.

A. A COMPETING TEAM IN FIRST-AID WORK.

B. RESCUE MEN ENTERING GALLERY IMMEDIATELY AFTER DUST EXPLOSION.

COMPANIES REPRESENTED.

The following list gives the names of the companies that sent teams to participate in the demonstration of first aid to the injured, with personnel of the teams and team numbers:

Berwind White Coal Mining Co., W. R. Calverley, general superintendent, Windber, Pa.—1. Squad No. 1: Captain, William Brownlee; John Swanson, Ralph Gibson, Nelson Smith, and H. E. Good; 2. Squad No. 2: Captain, George Grove; E. E. Fivecoat, Joe Bosco, J. Kreger, E. H. Seurfield, and Griff Llewellyn (subject); 3. Squad No. 3: Captain, J. C. Nedrow; J. L. Swanson, Willie F. Ream, Edmond Williams, Bert Sprague, and Lewis Berkey (subject); 4. Junior Squad: Captain, Ed. Greyback; Stewart Lape, Pierson Lewis, J. W. Walker, James Down, and James Jones.

Cabin Creek Y. M. C. A. Team, C. A. Cabell, president, Decota, W. Va.—5. Captain, E. B. Pierce; John Knight, William Smith, Ben Jones, and W. A. Gilchrist (subject).

Consolidation Coal Co., George T. Watson, vice president and general manager, Fairmont, W. Va.—6. Squad No. 1: Captain A. W. Hesse; Frank K. Day, L. A. Riggs, G. J. Altstetter, Homer Bell, and E. S. Bonnett (subject); 7. Squad No. 2: Captain, David Morgan; Daniel Porter, William Hendley, Arthur Jenkins, Alex. Neal, T. Price (subject).

Delaware, Lackawanna & Western Railroad Co., R. A. Phillips, superintendent, coal-mining department, Scranton, Pa.—8. Brisbin Colliery Squad: Captain, John Pierce; James Higgin, Frank Jones, John Schroeder, George Bennett, and Arthur Bennett (subject). 9. Woodward Colliery Squad; Captain, Benjamin Lewis; Neil McCole, John Smith, David Phillips, Edwin William, and W. Martin, jr. (subject).

Dunbar Furnace Co., Stuart B. Marshall, general superintendent; John T. Greaves, sr., superintendent, Dunbar, Pa.—10. Captain, John T. Bradley; Harry Bradley, John Stannis, George Greaves, and John W. Greaves, jr. (subject).

Ellsworth Collieries Co., W. A. Luce, general manager, Ellsworth, Pa.—11. Squad No. 1: Captain, E. C. Roberts; Peter Playfair, T. C. Coughlin, R. D. Maize, Fred Shilling, and James Kinsey (subject). 12. Squad No. 2: Captain, Fred Gulick; John North, Charles Davis, John Blytheway, Edward Ammon, and Daniel Leahy (subject). 13. Squad No. 3: Captain, George Lindsay; John Lindsay, Frank Feeney, Dave Roach, John Hughes, and Joe Lindsay (subject).

Lehigh & Wilkes-Barre Coal Co., C. F. Huber, vice president and general manager; Dr. F. L. McKee, surgeon in charge, Wilkes-Barre, Pa.—14. Captain, W. H. Evans; N. J. Connolly, Daniel Lewis, Raymond Lewis, William Craig, and Neil V. Gallagher (subject).

Lehigh Coal & Navigation Co., Baird Snyder, jr., general superintendent, Lansford, Pa.—15. Captain, Joseph Sweeney; John Boyle, Robert Sinyard, Alexander Jones, Bernard Cunning, John Priestly, Alexander Gibson (subject).

Lehigh Valley Coal Co., S. D. Warriner, vice president and general manager, Wilkes-Barre, Pa.—16. Squad No. 1: Centralia Mines: J. M. Humphries, superintendent. Captain, Harper G. Minnich; William Burke, John Wilson, Thomas Lamb, Alfred Ledicote, and Anthony Garvey (subject). 17. Squad No. 2: Deringer Colliery: W. H. Davies, superintendent. Captain, Ernest Crabtree; Simon Fellin, Joseph Fellin, Henry Bankeri, Oscar Brobst, and Isaac Morgan (subject).

Miller Coal Co., J. H. Buckwalter, superintendent, Portage, Pa.—18. Captain, E. G. Miles; G. W. Buckwalter, Harry McQuillen, Raymond Swanson, and Felix Boura (subject).

Northwestern Improvement Co., C. R. Claghorn, general manager, coal-mining department, Tacoma, Wash.—19. Captain, James Bagley; John Parker, John Hutchinson, Sam McCullough, and James Pascoe (subject).

Oliver & Snider Steel Co., Fred G. Keighley, general superintendent, Oliver, Pa.—20. Captain, Lewis Smitley; Thomas Lalley, John Tomash, John Kinic, James Bradee, and William Lalley (subject).

Parrish Coal Co., W. G. Thomas, general manager, Plymouth, Pa.—22. Captain, Thomas G. Maggs; Samuel Valentine, Harry Trebilcox, William J. Jones, John Metal, and Walter Davis (subject).

Pennsylvania Coal Co., Capt. W. A. May, general manager; Dr. F. F. Arndt, surgeon in charge, Scranton, Pa.—21. Captain, William Creedon; Harry Houston, George Kellam, Charles Warren, William Simmons, and Michael Burke (subject).

Philadelphia & Reading Coal & Iron Co., W. J. Richards, vice president and general manager; Dr. Geo. H. Halberstadt, surgeon in charge, Pottsville, Pa.—23. Wadesville Colliery: Captain, George Rubright; Edgar Rubright, Joseph Griffiths, William Raybold, Samuel P. Ray, and John Hale (subject).

Pittsburg-Buffalo Co., Marianna mines, S. C. Reynolds, superintendent, Marianna, Pa.—24. Captain, Sim Reynolds; Charles Sweet, Charles Waine, J. T. Reynolds, Earl Schrum, Charles Warrick (subject).

Pittsburg Coal Co., G. W. Schluederberg, general manager, Pittsburgh, Pa.; McDonald district, superintendent, L. C. Sarver.—25. Squad No. 1: Captain, S. W. Cramer; C. A. Nelson, C. A. Lawson, John Behling, Thomas Holleran, and Thomas Webber (subject). 26. Finleyville district, superintendent, James Porter. Squad No. 2: Captain, Alexander Waugh; John Bowles, Thomas McManus, Edward Lewis, William Feick, and Robert Duke (subject). 27. West Newton district, superintendent, John Hauser. Squad No. 2: Captain, Fred Jarvis; George M. Sterner, William Scott, Henry Hall, William Berger, and Peter Dorian (subject). 28. Carnegie district, superintendent, Henry Cattley. Squad No. 4: Captain, Ralph Bradley; Joseph Logue, O. C. Trimmer, Daniel Strang, James C. Barr, and George Wilson (subject). 29. Whitsett district, superintendent, William Kelvington. Squad No. 5: Captain, John Prebest; Burt Ramsey, John Stiffy, Roy E. Fox, Rock Colland, and Walter Stiffy (subject).

Pittsburg Terminal Railroad & Coal Co., W. W. Keefer, president, Pittsburgh, Pa.—30. Castle Shannon district, superintendent, John Mahoney. Captain, James Creehan; John Schneider, Richard Donnley, Joseph Kagle, Thomas Delaney, and Charles Kurtz (subject).

Portage Coal Mining Co., H. A. Tompkins, superintendent, Portage, Pa.—31. Captain, John Sweeney; William Filer, William Campbell, Edward Lamb, and Rudolph Canyok (subject).

Republic Iron & Steel Co., W. H. E. Royce, general superintendent; W. A. Perry, superintendent, Rupublic, Pa.—32. Captain, Logan Ross; Joseph Patterson, Charles F. Mills, John Laick, Frank Kabulish, and Dale Titus (subject).

Rochester & Pittsburg Coal & Iron Co., A. W. Calloway, general superintendent, Punxsutawney, Pa.—33. Captain, George Facemyer; Alexander Warden, Andrew Volinsky, Robert Patterson, Joseph Poydok, and Daniel McElhatten (subject).

Spring Valley Coal Co., S. M. Dalzell, general manager; J. H. Luther, assistant to the general manager, Spring Valley, Ill.—34. Captain, Anton Loeffler; George Condie, Edward Grossman, Michael Robouck, Charles Savio, and Anton Chiado (subject).

Stearns Coal & Lumber Co., J. E. Butler, superintendent, Stearns, Ky.—35. Captain, Tom Strunk; Reason Cecil, George Phillips, Burg Cecil, William Miller, and George Humble (subject).

Sunday Creek Co., Field Scott, superintendent, Poston, Ohio.—36. Captain, John Clark; James Taylor, Thomas McHarg, William Pritchard, James Williams, and Hugh Stewart (subject).

Susquehanna Coal Co., Robert A. Quinn, manager, Wilkes-Barre, Pa.—37. Captain, Peter Murphy; Frank Bonsock, Stanley Prush, George Perkins, Elias Negosh, and Andrew Barron (subject).

Tennessee Coal, Iron & Railroad Co., Edward Coxe, general superintendent, Birmingham, Ala.—38. Ensley district, superintendent, J. M. McHugh. Captain, A. H. Verchot; Francis Brawley, J. F. Brown, Will Flynn, Hugh Lynch, and Sandy Reid (subject).

Tower-Hill Connellsville Coke Co., L. W. Fogg, general manager, Uniontown, Pa.—39. Captain, H. O. Millward; Fulmer Neilson, John Action, William E. Meikrantz, and Henry Miller (subject).

Stag Canon Fuel Co., T. H. O'Brien, general manager, Dawson, N. Mex.—40. Captain, Winfield Smock; Robert Bossfield, W. E. Bayley, Jack McLaughlin, Ed. Thomas, Frank Dazzo (subject).

MINE-GAS TEST.

In order to demonstrate the effect of carbon monoxide (white damp) on men as compared with its effect on birds (No. 28 on the program), a glass-paneled box 6.5 feet high, 6 feet long, and 2.5 feet wide was constructed. In the presence of the spectators at Forbes Field sufficient carbon monoxide was forced into the box to produce an atmosphere containing 0.25 per cent of white damp. G. A. Burrell, assistant chemist, entered this atmosphere, taking three canary birds with him. The birds collapsed in three minutes, and were passed out of the box and held up by the legs to show the audience that they had collapsed. Two of the birds died, while the third subsequently revived. Mr. Burrell remained in the atmosphere eight minutes, but felt no ill effects from the exposure. On a previous occasion he remained in such an atmosphere for 20 minutes, but later became ill, although he felt only a slight headache at the time of exposure.

Canary birds have been used by the bureau in actual exploration work following a mine explosion, and have given warning of the presence of bad air, thus enabling the party with them to retreat in time. The history of exploration work after mine disasters is replete with instances of exploring parties zealously pushing on and taking desperate chances to rescue imprisoned men or to restore normal conditions. Many men have collapsed because of the afterdamp, and some have died. These risks will be largely eliminated if men will make use of the canaries as indicated above, and will use breathing helmets in exploring atmospheres that cause distress to birds.

EXPLOSION-GALLERY TESTS.

At 10.40 a. m. on October 31, in the Forbes Field gallery[a] a permissible explosive, equal in deflective force to one-half pound of 40 per cent nitroglycerin, was tamped with 1 pound of dry fire clay and was fired into the gallery (No 27 on the program). Result—No ignition; no flame visible.

At 11.05 a. m. a charge of FFF black powder, equal in disruptive force to one-half pound of 40 per cent nitroglycerin, was tamped with dry fire clay and was fired into the gallery. Result—Ignition; flame showed in all doorways and extended 50 feet out of end of gallery. The smoke issuing from the gallery is shown in Plate VI, *B*. A view of the President's box in the grandstand is given in Plate VIII.

RESCUE WORK.

Immediately following the coal-dust explosion two rescue crews, protected by breathing apparatus, entered the open and smoking mouth of the steel gallery (Pl. VII, *B*) to rescue the supposed victims and bring them to first-aid corps for treatment. Each crew consisted of 10 men and captain. The crews proceeded across the field to the open end of the steel gallery, entered the gallery, and returned with supposed victims.[b] The second team was held in reserve while the first team entered the gallery, and while the second team was in the gallery the first team was held in reserve. The teams were composed of foremen miners of the Bureau of Mines, aided by squads representing the Illinois Mine Rescue Station Commission, the Philadelphia & Reading Coal & Iron Co., and the Pittsburgh-Buffalo Co. Each squad was equipped with some type of breathing apparatus.

The first crew entered the gallery and recovered three supposed victims of the explosion, brought them from the gallery and placed them in care of foremen miners and first-aid miners of the Bureau of Mines, who demonstrated the proper treatment of the following accidents, using the pocket first-aid packets only and such things as might be available in a mine after an explosion.

Accident 1.—Miner overcome by afterdamp and having lacerated scalp. Treated by C. O. Roberts, first-aid miner.

Accident 2.—Miner slightly overcome by afterdamp and suffering from simple fracture of right thigh and compound fracture of right

[a] The Forbes Field steel explosion gallery was cylindrical, 135 feet long, internal diameter 6 feet 4 inches, and represented an underground tunnel or part of a coal mine. The explosive was fired into the end of the gallery, within which were 133 pounds of fine coal dust from the Pittsburg bed, distributed uniformly throughout, and 20 pounds on a wooden bench 20 feet long near the mouth of the cannon, making a total of 153 pounds of coal dust.

[b] Moving pictures of this demonstration have been shown throughout the country.

forearm near wrist. Treated by W. A. Raudenbush and William Burke, foremen miners.

Accident 3.—Miner overcome by afterdamp and suffering from simple fracture of right collar bone and simple fracture of the left arm. Treated by J. T. Ryan, junior engineer, and G. T. Powell, first-aid miner.

While the first-aid treatment of the three hypothetical accidents enumerated above was being exhibited an ambulance drove across the field and appeared at the scene of the supposed disaster, where it furnished bandages, stretchers, and first-aid supplies. The stretchers used for the first three accidents were improvised by the use of gas pipe and miners' blouses, and of boards and brattice cloth. The subjects were then placed on the improvised stretchers and carried to the ambulance as soon as it arrived.

The second rescue party in the meantime entered the gallery, brought out two supposedly injured miners and placed them in care of the first-aid squad, which, with the first-aid supplies furnished by the ambulance, exhibited the proper treatment of the following accidents:

Accident 4.—Miner overcome by afterdamp and burned about face, neck, ears, and hands. Treated by W. A. Raudenbush and William Burke, foremen miners.

Accident 5.—Miner overcome by afterdamp and burned from waist line up. Treated by J. T. Ryan, junior engineer; G. T. Powell and C. O. Roberts, first-aid miners.

The ambulance used was gratuitously furnished by Mr. M. A. Hanlon, funeral director, through the joint courtesy of himself and the Pittsburgh Hospital.

PRESENTATION OF TROPHIES.

Following the demonstration of rescue and first-aid work just described, formal presentation of trophies was made. Hon. John K. Tener, governor of Pennsylvania, acted as chairman and master of ceremonies during this part of the program. In opening the exercises, Gov. Tener spoke as follows:

MR. PRESIDENT, LADIES, AND GENTLEMEN: This day, date, and occasion will ever be a memorable one, and to you who participated in it it will prove a pleasant reflection—all except the weather. It is fitting and proper that these tests should be made in Pittsburgh, the center of the soft-coal industry of the United ~~States. It is proper that you should assemble for an affair of this kind in the~~ center of the greatest coal-producing area in the entire world.

You have witnessed these great tests, and I find special pleasure in introducing to you at this time the man who is at the head of that department of our National Government which includes the Bureau of Mines, one of the branches of the National Government which is doing so much for Pennsylvania at this time. I present to you Walter L. Fisher, Secretary of the Department of the Interior.

Secretary Fisher said:

Recently there has gone through this country an unexampled wave of popular sentiment in favor of conservation. But it is necessary that conservation be based on something else than sentiment and that it be shown to be practical in nature. That is the reason for a demonstration like the one we have seen here to-day. The work of the Bureau of Mines typifies the true spirit of conservation. It demonstrates what is wasted in our natural resources. There are two kinds of waste. There is that kind which does not make full use of all the resources at our command, and there is that kind which allows a chosen few to tie up our natural resources to the detriment of the many. But the greatest waste of all is that of human life and human energy. It is that waste which must be prevented first of all. It is that waste which the Bureau of Mines is bending every effort to reduce to a minimum. You will notice on your program that safety first is the motto of the Bureau of Mines. My personal interest in this work, therefore, brings me here to-day, and about all I can say to you boys is that we welcome your cooperation, or, rather, I should say, that we offer you our cooperation. Because, after all, safety in the mines depends on the miners themselves. They must prevent disaster, they must rescue after havoc has been wrought. It was a splendid demonstration which we witnessed here this morning, and in the name of the Bureau of Mines and the National Government I congratulate all those who took part in it.

Miss Mabel Boardman, of the executive committee of the American National Red Cross, was the next speaker on the program. In introducing Miss Boardman, Gov. Tener said:

Living as I do (as most of you know) near the coal mines of the Monongahela Valley, I am especially interested in this work, and I am glad to see so many representatives of the mines and so many first-aid teams here. I have been interested in the Monongahela district for many years, during which time I have known of more than one explosion that has occurred, and I have seen the distress and the havoc that most explosions wrought. I am therefore in sympathy with all that is being done to-day, all that is shown by these tests in your methods of life-saving, and in the conservation of human life. These great explosions do occur and when they do occur succor is needed promptly, and we have a representative of that society which has done more in times of war and in times of peace to relieve the suffering that results than any other agency or any other influence in the world. I have the pleasure at this time of presenting a prominent officer of the society, a member of the executive committee of the American National Red Cross, Miss Mabel Boardman.

Miss Boardman's address was as follows:

MEN AND WOMEN OF PITTSBURGH: The duty of the American Red Cross is to give relief after great disasters. The fact that 2,000 of our miners yearly lose their lives in the mines and that many thousands more are injured at their work is an appalling national calamity. What are we going to do about it? It isn't enough for the Red Cross and others to organize pension systems to care for the widows and orphans. What are we going to do to prevent the wives becoming widows and the children orphans? What are we going to do to prevent this sacrifice of human life?

You have seen the admirable work the Bureau of Mines is doing for the prevention of disaster and the rescue of the miners in case of accident. You have seen what the Red Cross is doing for the training in first aid to the injured, and you, every one of you, must give your help in this great work. Will you who represent the companies, aided by the Red Cross, arrange for courses whereby the men can be taught their part in the prevention of injury to themselves and others, whereby the men can be taught first aid to the injured, for the fate of a wounded man depends upon those into whose hands he first falls. The companies' own interest commends this to you, but more than self-interest, it is the great cry of humanity that calls to you in this work.

Will you miners do your part? Learn how to prevent accidents. Learn how to give first aid to the injured men. You have seen to-day what splendid work many of your fellow miners have learned to do by their earnest study and practice. You can learn to do the same. Think what this first aid may mean to the wives and children that you love; how it may save you and others from a crippled life. More than this, how it may mean the very difference between life and death itself. Will you do your part?

But this is not enough, men and women of Pittsburgh. You, too, must do your share. There are your fellow men whose bodies may be crippled, whose lives may be lost in the mines. The Red Cross calls to you to aid and sustain it in its efforts to push forward this great work for the conservation of human life.

In introducing President Taft, who was to award the trophies, Gov. Tener said:

We have present, as an invited guest, and as the special guest within our borders to-day, both Pennsylvania and Pittsburgh, he who has done more for Pittsburgh—for Pennsylvania—during the past three years, in my mind, than any other President who has ever served us in the presidential chair. He has worked hand in hand with the work you have seen to-day, in the encouragement of it, and especially the encouragement given to the improvement of our rivers and harbors, and all the things which mean Pittsburgh's future prosperity and happiness have been given by our distinguished guest.

I remember well taking a trip by river from Cairo to New Orleans in company with President Taft. That trip and its itinerary were under the auspices of a Pittsburgh association. I remember that though he was not convinced that the entire project was feasible he, nevertheless, unhesitatingly committed himself to the improvement of that portion including the Ohio River from Pittsburgh to Cairo and had the project put into action as soon as it could possibly be done. And so Pittsburgh receives great benefit to-day from that great project by being provided a way to market our products speedily and to deliver them in the Middle and Far West in competition with producers located in that district. I know that when it is the plan to connect Lake Erie with the Ohio River and give us the ship canal we all want, he will, for the sake of Pittsburgh and the Ohio Valley throughout, aid us in every way he can.

I have special pleasure in introducing the President of our Nation, His Excellency, William H. Taft.

President Taft spoke as follows;

I thank the governor for his kindly introduction. It is a great pleasure to be here on this important occasion. Properly is it on the soil of Pennsylvania that has so large a part within its borders of the mining industry of this country; 300,000 miners with dependent families live in Pennsylvania, and therefore this State, more than any other, is interested in the cause of saving the lives of the miners. There are 700,000 miners in this country. In 10 years last past, 30,000 of them gave up their lives and 70,000 of them were wounded in the mines by reason of mining explosions and other accidents, one-seventh of the entire body of miners in 10 years. That is not a record to be proud of, and it is time indeed that we should take steps to restrain and restrict this loss.

The establishment of the Bureau of Mines in the Federal Government was taken chiefly to initiate the movement and restrict and lessen the loss of life. The Federal Government has no direct jurisdiction, but it has the money and it has the spirit, and it has the authority under the Constitution to act for the general welfare of the people. It has, therefore, the right to expend the money and show to all the mining bureaus of the States and all the State authorities the correct methods to pursue to save the lives of their miners.

As Secretary Fisher has said, ultimately this must come home to the individual miner; ultimately we must depend upon his attention to the safety of himself and his fellows.

We are a great Nation. We know it, because we admit it; and we have a most intelligent population; but there are some defects that with a microscope you can discover, and one is a certain sort of a security about ourselves that we are not going to be hurt, and that we can look after ourselves. Now, we want to get over the idea that the force of gravity and the force of explosion do not apply to American citizens. We want to get into our heads the idea that we must take precautions if we would save life, and we want to impress that upon the miners who themselves are exposed in the mines. It requires discipline; it requires instruction; it requires experience, and we have miners who have all of these; and we must enforce through the State agencies, with the information that the Federal Government gives, this lesson, and must emphasize that the miners themselves must save themselves—with the knowledge and the appliances that the employers must supply; and the information that the Government must furnish; and the laws and inspection that the State must give to the miners. All these agencies cooperating must make our mines safer than they now are, hence the importance of this movement.

I am glad to see here the governor of Pennsylvania and the governor of West Virginia, those great mining States. I am glad to see here the head and the moving spirit of the Red Cross, Miss Mabel Boardman, who sees in the tremendous loss of life and limb due to these accidents the opportunity for the application of the resources of that great association to help mankind. And I am glad to have the Secretary of the Interior here, with his energy and force, and also the head of the Bureau of Mines, who is making such progress in developing the secrets of explosives, so that we can learn how to use them without hurting ourselves. I do not know an occasion that is more important in the development of industry than this one right here, and in this hive of industry, Pittsburgh, to develop that sort of conservatism, that sort of security, that sort of insurance against accident and loss of life that all common-sense men ought to embrace. We must stamp out the spirit of carelessness and the happy-go-lucky idea that I am afraid is too common with Americans generally.

Now, I feel great honor in presenting tokens to these worthy men, these worthy miners, who come out of the mines, conscious of what can be done and anxious to excel in doing that which men ought all to do—the saving of lives of their fellow men and of themselves, the aid of the wounded, the aid to the unfortunate. It is an inspiring sight to see how they have learned to make themselves ready-made surgeons. It is an inspiring sight to see men take their lives in their hands and enter such a hell as that over there in that black tube [indicating the explosion gallery at the other end of the field in which a coal-dust explosion had just occurred]. It is an inspiring sight to see them bring out their fellows, who have been unfortunate, and revive them and bring them back to useful lives again.

And now it becomes my happy fortunate function to present to the representatives of the miners who have been engaged in this exhibition, and who on previous trials demonstrated their skill, the evidence presented by the association in the form of medals and by the Red Cross in the form of first-aid packages.

The President then handed the Red Cross medals and the first-aid packages to the captains of each of the first-aid and mine-rescue teams[a] as they marched by, each team stopping for a moment to receive its tokens.

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[a] See list on pp. 45–47.

RESEARCH WORK AT THE PITTSBURGH EXPERIMENT STATION.

Since the main feature of the demonstration discussed in this report was safety, only a mere outline can be given of many other important investigations, which, though they are being conducted by the bureau, were not fully represented in the demonstration.

The chief purpose of the Bureau of Mines is to conduct investigations and inquiries concerning mining, the treatment of mineral substances, and the utilization of fuels with a view to increasing safety and efficiency and preventing waste in the development and utilization of the mineral resources in the United States.

The investigations and research work of the bureau are chiefly carried on at the Pittsburgh experiment station and are under the immediate supervision of the engineer in charge.

SPECIAL INVESTIGATIONS RELATING TO COAL.

In addition to the mine-safety investigations mentioned in the foregoing pages, the Bureau of Mines is conducting investigations of a general nature which are of vital interest to the mining industry and to the public at large. Among these investigations is included a study of fuels, including lignite, petroleum, natural gas, and producer gas, but especially embracing coal—the briquetting of low-grade coal, waste in coal mining, etc.

BRIQUETTING PLANT.

With the briquetting plant (Building No. 32), extensive investigations have been conducted on the briquetting qualities of American fuels, including experiments with anthracite, bituminous coal, lignite, and peat. Two types of briquetting machines are used, a German lignite-briquetting press and an English briquet machine.

The German press is adapted only for those types of peat and lignites which contain sufficient natural binder to form briquets under pressure. The object of the tests with this press is to determine whether American lignites can be briquetted without the use of artificial binder. At this plant briquets have been successfully made from California, North Dakota, and Texas lignites.

On the day of the demonstration, October 30, the English machine made briquets of Pittsburg slack and 6 per cent of water-gas pitch binder, and the German equipment was operated to demonstrate the crushing, drying, and pressing of California lignite (which had been out of the mine three years) into firm briquets without the addition of binder. Samples of North Dakota, Texas, California, and Philippine lignitic coals and of briquets made from these fuels were exhibited.

The results of the tests made by the briquetting section have demonstrated the practicability of converting fuel waste and low-grade fuels into briquets for commercial purposes. The briquetting tests are under the supervision of O. P. Hood, chief mechanical engineer, with C. L. Wright, engineer, in immediate charge.

BY-PRODUCTS, DUST, AND GAS.

Destructive distillation.—The destructive-distillation apparatus, exhibited in rooms 27, 29, and 31 of building 21, is used in testing coal for gas, tar, ammonia, and other by-products of destructive distillation.

Coal dust.—An apparatus was shown in which a cloud of coal dust, suspended in an atmosphere of inert gas (nitrogen), is for a brief time heated by a hot platinum coil and the volatile products determined. This experiment bears upon the study of the primary steps in the decomposition of coal by heat and incidentally, therefore, upon that of coal-dust explosions.

Occluded gas.—Experiments were shown in which the rate of evolution of occluded gas and the rate of absorption of oxygen by coal were being studied. Gas (methane) is given off by some coals abundantly for a long time after mining, and by others only in slight quantities for a short time.

Spontaneous combustion.—The study of the effect of temperature upon the rate at which oxygen is absorbed by or acts upon coal, producing spontaneous heating, was illustrated by an apparatus in which air was passed over coal in a tube electrically heated to different temperatures. This research has a direct bearing on questions concerning spontaneous combustion of coal in mines or in storage.

Weathering.—Investigations and tests are made concerning the loss of heating value and volatile content due to the weathering of coal and to its storage under cover, in air, or under fresh or salt water.

The work of these coal investigations is under the direction of H. C. Porter, chemist, and F. K. Ovitz, assistant chemist.

CHEMICAL CONSTITUTION OF COAL.

Rooms 23 and 25 of building 21 are devoted to research work on the chemical constitution of coal and an investigation of the relative explosibility of coal dusts. The problem of the constitution of coal is being attacked in these laboratories by the method of extraction with solvents and the subsequent examination of the fractions separated. Use is made of organic solvents to separate unchanged the chemical compounds that constitute the complex material known as coal. After these substances have been isolated, the next step is their identification.

The visitor of October 30 had exhibited to him the general method involved. At that time the solvent in use was ether. Samples of the pyridin-soluble material of a Pittsburg coal were exhibited, as well as the ether extract of that particular fraction of the coal. Methods of extraction and distillation employed were also exhibited.[a]

The laboratory apparatus used in the investigation of the relative inflammability of coal dusts was exhibited, and demonstration of the use of this apparatus was given from time to time. Curves were also shown giving the results obtained for a number of coals and for mixtures of coal with shale dust, as well as for samples of gluten, asphalt, and wood dusts.

This special research work is under the direction of J. C. W. Frazer, chemist; E. J. Hoffman, assistant chemist; and L. A. Scholl, jr., junior chemist.

FUEL-ANALYSIS LABORATORY.

The fuel-analysis laboratory, rooms 3, 7, and 32 of building 21, is occupied mainly with the analyses and calorimetric testing of solid fuels, including coal, coke, lignite, and peat. The samples submitted for analysis are taken from all fuels used in boiler and gas-producer tests, or from mines investigated by the engineers of the bureau. Ultimate analyses and calorimetric determinations are made of some of the mine samples and of mine and prospect samples of coal and lignite collected by the United States Geological Survey, as well as by certain State geological surveys. The data from these tests are of value in establishing the composition and heating value of the coals belonging to the United States.

Room 3, in which all calorimetric determinations are conducted, is equipped with five bomb calorimeters. The bomb calorimeters are capable of measuring the heating value of a fuel, in terms of calories or British thermal units, with an error not exceeding 0.25 of 1 per cent.

Room 7 is especially equipped for the air drying of the coarse sample of coal, and for its subsequent pulverization and reduction to the laboratory sample.

Room 32 is devoted to the proximate and ultimate analysis of fuels, and to certain miscellaneous analytical work incident to fuel-testing and mine investigations. The apparatus is arranged for analyzing a

[a] A detailed account of the procedure followed and of the results of a preliminary investigation is given in Technical Paper 5, Bureau of Mines: The constituents of coal soluble in phenol, by J. C. W. Frazer and E. J. Hoffman, 1912, 20 pp.

number of coal samples as rapidly as is consistent with accurate results. In general, the method recommended by the committee of the American Chemical Society, modified in certain respects, is used. Moisture is determined at 105° C. in a constant-temperature oven, through which air that has been dried over sulphuric acid is passing. Ash is determined on the same sample by heating it to constant weight in a muffle furnace, the temperature of which is about 800° C. Volatile matter is determined in a 30-c. c. platinum crucible placed 1 cm. above the top of a Meker burner, with the gas orifice so adjusted as to give a free flame 16 to 18 cm. in length when the gas is supplied at a pressure of 33 cm. of water. The burner and the platinum support for the crucible are inclosed in a draft-proof sheet-iron stand. The total carbon and the total hydrogen are determined by combustion in a current of oxygen, and the volatile matter evolved by passing over heated copper oxide to aid in procuring complete combustion. Two gas combustion furnaces are usually operated simultaneously by one analyst. Nitrogen is determined by the Kjeldahl-Gunning method. The apparatus has a capacity of 12 simultaneous determinations. Sulphur is determined by the Eschka method.

The personnel of the fuel-testing laboratory is as follows: A. C. Fieldner, assistant chemist; G. E. Webster, D. I. Brown, A. M. Wedd, F. D. Osgood, and W. A. Selvig, junior chemists; and W. E. Surbled and Morris Block, laboratory assistants.

COMBUSTION IN BOILER FURNACES.

A special furnace with a combustion chamber nearly 40 feet in length and about 9 square feet in cross section was in operation on October 30. This furnace was designed for the investigation of the process of combustion in boiler furnaces and of the conditions necessary for the complete combustion of different coals at different rates of firing and with different air supply through the grate and above the fuel bed.

For the purpose of determining the completeness of combustion at different parts of the chamber, many gas samples are collected by means of water-cooled sample tubes. Temperatures of furnace gases are measured by means of an optical pyrometer.

The chamber space necessary for practically complete combustion depends on the following factors: Nature of coal used, rate of combustion, supply of air, rate of heating fuel, and rate of mixing volatile combustible matter and air. The experiments contemplated will require tests on six or more typical kinds of coal.

The work is in charge of J. K. Clement, physicist, and C. E. Augustine, assistant engineer, and is under the general direction of O. P. Hood, chief mechanical engineer.

SMOKELESS COMBUSTION OF COAL.

Experiments are being conducted in building No. 13 with three mechanical stokers.

One of these stokers is of the traveling link-grate type, in which the fuel is fed into the furnace slowly and uniformly as the grate advances into the furnace. As the coal enters the furnace it passes under a flat arch of refractory material, the heat from which slowly distills or drives off the volatile matter. The noncombustible portion of the coal (the ash) passes over the rear of the grate and falls into the ash pit. The fact that the volatile matter is slowly and uniformly driven off, and that the gases must travel almost to the rear of the boiler before passing among the tubes, makes possible the burning of high-volatile coals without smoke.

The second stoker, which was in operation on October 30, is of the inclined-grate, side-feed, and overfeed type. This stoker is connected to the long-combustion chamber. In it the grates are in two planes arranged as a V. A pusher plate feeds the coal at either side of the furnace to the top of the inclined grates. This pushing of green coal on the upper end of the grates, combined with the slight motion imparted by the driving mechanism to each alternate grate bar, works the fuel down to the bottom of the V, where the ash is removed. An arch of refractory material is sprung across the top of the furnace and the heat from this effects the distillation of the volatile matter gradually as the coal enters at the sides and top of the furnace.

The third stoker is the underfeed type. The coal is uniformly fed into the furnace by a ram. Air for burning the fuel is supplied by a forced-draft fan and is forced into and up through the fuel bed from tuyère blocks around the periphery of the retort into which the ram forces the coal. Combustion takes place at or near the surface of the fuel bed, but the coal is gradually heated as it works up from the retort toward the top of the fuel bed. The volatile matter driven off, as the coal becomes heated, mixes with the air from the tuyeres and burns near the surface of the bed of fuel.

The boilers and stokers in this building (No. 13) are used for furnishing steam for heat and power and for experimental purposes as well. Provision has been made for taking temperatures, strength of drafts, and other observations in various parts of the settings, so that tests of any coal can be made to determine its suitability for use with several kinds of equipment.

These experiments are under the general direction of O. P. Hood, chief mechanical engineer, and in immediate charge of S. B. Flagg and C. D. Smith, engineers.

STEAMING TESTS.

The return-tubular boiler in building No. 21 is 60 inches by 16 feet, with forty-four 4-inch tubes. The setting of this boiler was designed so as to make possible the burning of high-volatile bituminous coals, such as that from the Pittsburg bed, without violating a smoke ordinance that allows only 6 minutes' emission of dense smoke in any hour.

With such a furnace it is possible to burn slack coal from the Pittsburg bed at the rate of 15 pounds per square foot per hour without violating an ordinance such as that mentioned. With some modifications in the setting, the coal mentioned could doubtless be burned at a rate of 20 pounds per square foot of grate surface per hour without producing any more smoke.

In the conduct of boiler tests, the Orsat gas-analysis apparatus is used for the purpose of determining the quantity of air being supplied for combustion and of governing the fires accordingly.

During the tests on the return-tubular boiler the water fed to the boiler is automatically weighed and the quantity of water recorded. The water weigher, which is near the feed pump, does not actually weigh the water, but measures it in two compartments which are alternately filled and dumped. A counter registers the number of times these compartments are filled, and from these data the weight of water can be computed when the temperature of the water is known.

The three smaller boilers in the boiler room of building No. 21 are types used in heating practice. The largest of these is suitable for large residences, schoolhouses, or public buildings, and the two smaller ones are intended for residences of ordinary size.

One of the smaller boilers in building No. 21 is used in conducting tests for the Quartermaster's Department of the United States Army. The coals so tested come from all parts of the United States, Alaska, and the insular possessions; also from Japan, Australia, and other countries.

These tests are under the direction of O. P. Hood, chief mechanical engineer, with S. B. Flagg, engineer; H. H. McKee, assistant engineer; and Charles Schramm, fireman, in immediate charge.

PRODUCER-GAS PLANT.

The producer-gas plant in building No. 13 is being operated in an experimental way, at high temperatures. The clinker is tapped off as a liquid slag.

Carbon monoxide is one of the most important constituents of producer gas, but its most satisfactory formation requires high temperatures. In the commercial operation of gas producers, one of the difficulties frequently encountered is the accumulation of clinker resulting from high temperature in the producer. In order to avoid excessive clinker an effort is always made to keep the temperature below that at which the ash fuses. In the producer in building No. 13 no attempt is made to facilitate high temperatures, but rather to prevent them in order to promote the formation of carbon monoxide. The ash melts into a liquid slag which is tapped off at regular intervals. To aid in fluxing the ash, and to make it more liquid, a small amount of limestone is added to the fuel charge. Coke has been used as fuel, but the schedule of tests includes several coals as well as low-grade and high-ash fuels.

The work is under the direction of O. P. Hood, chief mechanical engineer, with C. D. Smith, engineer, and F. E. Woodman, assistant engineer, in immediate charge.

FOUNDRY CUPOLA.

The work at the foundry cupola (building No. 13) embraces the taking of gas samples and temperatures in the various zones of the coke bed for the purpose of studying the fundamentals of the melting process, with a view to possible improvement.

The equipment used consists of an ordinary 36-inch foundry cupola, reduced by lining to 26 inches, which has four horizontal 4 by 6 inch tuyères 3 inches above the sand bottom. This cupola is arbitrarily divided into five zones, which contain gas and temperature tubes. In each zone three samples of gas and three temperature measurements are taken for the purpose of determining at what point the metal melts most advantageously and is least injured by the oxygen of the blast. The results are expected ultimately to show what are ideal melting conditions and to furnish exact information in regard to melting practice. The work of the foundry cupola is in charge of A. W. Belden, engineer.

FURNACE-GAS LABORATORY.

This laboratory is in building No. 13, and is used exclusively for the analysis of gas from the long-combustion chamber, gas producer, and cupola. The personnel of the laboratory is as follows: A. E. Hall, junior chemist, in charge, assisted by L. L. Satler and E. T. Gregg, junior chemists.

PETROLEUM LABORATORY.

The petroleum laboratory in building No. 21 comprises six rooms fully equipped for petroleum analyzing and testing. The laboratory contains the following standard and special apparatus:[a]

[a] For more detailed description see Bulletin 19, Bureau of Mines: Physical and chemical properties of the petroleums of the San Joaquin Valley, Cal., by I. C. Allen and W. A. Jacobs, with a chapter on analyses of natural gas from the southern California oil fields, by G. A. Burrell. 1911. 60 pp., 2 pls.

Abel-Pensky and Pensky-Martens flash testers for the determination of the flash and ignition points of light and heavy oils, respectively; Engler, Sayboult, Redwood, and Taliabue viscosimeters for the determination of so-called "viscosity"; electric separator for the treatment of water-oil emulsions; electric still, ¼-liter capacity, and vacuum equipment for laboratory fractionation of petroleum; washing machine and centrifuge for refining petroleum products; Ives and Stammer colorimeters for the determination of colors of oil products; photometer and lamps for the measurement of the light given off by burning oils; Dinsmore-Atwater calorimeter for calorimetric determinations; electric still of 10-liter capacity for the fractionation of petroleum in commercial quantities.

The elemental analysis of oil products is made in the Dennstedt platino-asbestos furnace and in the Carius pressure oven.

The refractive indices are determined on the Abbe universal refractrometer.

Saponification tests are made in a specially constructed high-pressure autoclave.

The petroleum laboratory is in charge of I. C. Allen, chemist, with W. A. Jacobs and R. R. Matthews as junior chemists.

PHYSICAL LABORATORY.

During the demonstration the physical laboratory exhibited electrical pyrometers (thermocouples) for the measurement of temperatures, a comparator and electric furnaces for the calibration of thermometers and pyrometers, apparatus for the study of thermal conductivity at high temperatures, and apparatus used in an investigation of the influence of carbon dioxide on the explosibility of mine gases.

THERMOMETERS.

In investigations concerning the economical use of fuel for the generation of heat and power, an accurate knowledge of the temperatures produced in the various parts of the furnaces used is of great importance. The selection of the type of thermometer or pyrometer best suited for a particular purpose will depend largely on the range of temperatures to be measured. In the work of the Pittsburgh experiment station a number of different types of apparatus are used. Mercury thermometers are used for temperatures up to 700° F. For temperatures between 700° F. and 2,200° F. thermocouples are used, and for temperatures over 2,200° F. optical or radiation pyrometers are used.

HEAT RADIATION.

It is well known to those who are familiar with the operation of boiler furnaces that a part of the heat produced by the combustion of the fuel is lost by radiation from the walls of the furnace. In an endeavor to reduce the amount of heat by radiation, experiments are being conducted in the physical laboratory to determine the thermal conductivity of various refractory materials with reference to their use in the construction of furnace walls.

EXPLOSIBILITY OF MINE GASES.

An investigation that has just been completed in this laboratory had for its object the determination of the explosibility of mine gases, and especially of the influence of carbon dioxide on the explosibility of mixtures of methane and air. The mixtures were subjected to an arc produced by breaking a 220-volt circuit. The experiment showed that explosive mixtures of methane and air may be rendered nonexplosive by the addition of a sufficient quantity of carbon dioxide.

The work of the physical laboratory is carried on by J. K. Clement, physicist in charge, and W. L. Egy, assistant physicist.

MINING-ENGINEERING INVESTIGATIONS.

Mining-engineering investigations may be summarized under two heads: Those for lessening accidents and those for lessening mine waste. Under the first head come investigations of explosions in coal mines, both of gas and coal dust (in charge of G. S. Rice); investigations of mine fires, both in coal and metal mines (in charge of R. Y. Williams); investigation of the use of mine explosives, as concerns safety and efficiency (in charge of J. J. Rutledge); investigations of falls of roof and of miscellaneous mine accidents (in charge of J. J. Rutledge).

An important subdivision of the investigation of mine explosions, looking toward lessening or preventing them, are the experiments conducted at the experimental mine near Bruceton, Pa. These experiments are in general charge of George S. Rice, chief mining engineer, L. M. Jones, engineer, assisting; the testing of instruments is in charge of J. K. Clement, physicist, W. L. Egy, assisting.

Under the second general head, lessening mining wastes, come problems of efficiency—mining methods, affecting both waste and safety or damage to surface property. Such a problem is the one of surface subsidence and mine caves in the anthracite fields of Pennsylvania. This work is in charge of Charles Enzian, engineer.

The foregoing investigations are all well started. Other problems, more especially in mining methods, are being touched upon as opportunity offers. Meantime, the scenes of all important mine fires and explosions are visited by one or more members of the force.

A great many samples of coal are gathered from mines in various parts of the country for analysis and testing for the Navy, War, and Treasury Departments. The work of this section is under the general charge of George S. Rice.

COMPUTING, DRAFTING, AND PHOTOGRAPHIC SECTION.

The computing, drafting, and photographic section of the Bureau of Mines may be termed a "common-service" section in that it is at the call of all the investigating engineers and chemists of the bureau for work in connection with the keeping of records and preparation of data for reports of their investigations. The computing consists in the reduction of test data—in connection with fuel-efficiency tests, explosives tests, and special tests and analyses of fuels and gases—to a final condition of completeness such that the testing engineer can incorporate the results directly in his report.

The photographic laboratory in building No. 21 is arranged and fully equipped to do work incident to the keeping of complete photographic records of equipment, methods of work, and results of tests.

The following is the personnel of the division: L. M. Stone, engineer in charge; R. A. Wood and L. Griffin, junior mining engineers; E. Skilling and T. F. Perry, draftsmen; O. A. Morrow, photographer; L. L. A. Moran, aide.

LIBRARY.

The library receives (by exchange or purchase) many of the technical journals and periodicals published in this country or abroad. Books and other publications pertaining to the bureau's work are being added as rapidly as is practicable. The librarian, O. L. Schwarz, acts as translator. Through him the engineers and chemists are kept in touch with the latest foreign experiments.

INSTRUMENT MAKER'S SHOP.

The instrument maker's shop is provided with all tools, apparatus, and appliances necessary to the design, improvement, and repair of mine-safety lamps and apparatus and metal or glass physical and chemical instruments.

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CLASSIFIED LIST OF VISITORS.

The following pages give the names of as many of the visitors as it is possible to obtain. An attempt has been made to include the names of all those who were in attendance in an official capacity as representatives of the Federal, State, or foreign governments, of mining and manufacturing companies, of labor organizations, and others interested in first-aid work and safety devices in mining and industrial plants. If the name of any visitor does not appear, the omission is the result of his failure to register. Registration cards were distributed to all, with the request that each person register in order that the list be complete.

In addition to those named there were several thousand persons in attendance at Forbes Field, including many miners. Although their names do not swell the published list, yet their presence at the demonstration indicated their interest in this work. It is hoped that each one returned to his regular work in mine, mill, or factory as a missionary bearing the gospel of safety.

UNITED STATES GOVERNMENT OFFICIALS.

The President, William H. Taft.
Charles D. Hilles, Secretary to the President.
Maj. Archibald Butt, United States Army, Aide to the President.

DEPARTMENT OF THE INTERIOR.

Hon. Walter L. Fisher, Secretary of the Interior.
Clement S. Ucker, chief clerk.
Dr. J. A. Holmes, Director, Bureau of Mines.
Van. H. Manning, chief clerk, Bureau of Mines.
George Otis Smith, Director, United States Geological Survey.

DEPARTMENT OF AGRICULTURE.

Hon. W. N. Hays, Assistant Secretary of Agriculture.

UNITED STATES ARMY AND NAVY.

Rear Admiral Austin Knight, United States Navy, Bureau of Ordnance.
Col. H. C. Newcomer, United States Army, Corps of Engineers.
Col. E. B. Babbitt, United States Army, Ordnance Department.
Col. W. L. Langfitt, United States Army, Corps of Engineers.
Capt. R. C. Moore, United States Army, Corps of Engineers.
Ensign George W. Struble, United States Navy.

UNITED STATES CONGRESS.

Senator George T. Oliver, Pennsylvania.
Representative A. J. Barchfeld, Pennsylvania.
Representative James Francis Burke, Pennsylvania.
Representative John Dalzell, Pennsylvania.
Representative C. H. Gregg, Pennsylvania.
Representative Stephen A. Porter, Pennsylvania.
Representative D. J. Lewis, West Virginia.
Representative Martin W. Littleton, New York.
Representative Nicholas Longworth, Ohio.
Representative George P. White, Ohio.

FOREIGN REPRESENTATIVES.

Canada.—J. G. S. Hudson, department of mines, Ottawa, Ontario; E. T. Corkhill, chief inspector of mines, Toronto, Ontario; R. F. Tolmie, department of mines, Victoria, British Columbia; R. Strachan, inspector of mines, Hosmer, British Columbia; J. C. Murray, editor in chief, Canadian Mining Journal, Toronto, Ontario; James McMahon, superintendent of rescue work, Dominion Coal Co., Glace Bay, Nova Scotia.

France.—M. de Puligny, chief engineer of bridges and highways, head of the Mission of French Engineers in the United States, personally representing Ambassador Jusserand.

Mexico.—Señor Abram Ferriz, inspector of explosives, Torreon, Coahuila, Mexico.

STATE AND CITY OFFICIALS (OTHER THAN MINE INSPECTORS).

Illinois.—Mine Rescue Station Commission of the State of Illinois: Dr. J. A. Holmes, chairman; Prof. H. H. Stoek, secretary; Hector McAllister, vice chairman; Richard Newsam, manager; J. L. Schmidgall; Charles Krallman; Charles Bennett; Harriett Reid, clerk; M. F. Cummings, J. C. Duncan, Thomas English, Alexander Jones, Thomas Lawless, Thomas Rogers, James Towal, helmetmen.

New Jersey.—H. B. Kümmel, State geologist, Trenton.

New York.—J. S. Whalen, first deputy commissioner of labor, Albany.

North Carolina.—J. Hyde Pratt, State geologist, Charles Hill.

Ohio.—C. E. Adams, president chamber of commerce, and G. W. Kinney, ex-president chamber of commerce, Cleveland.

Pennsylvania.—Gov. John K. Tener, Harrisburg; R. R. Hice, State geologist, Beaver. Allegheny County: J. Denny O'Neil, Irving K. Campbell, and S. J. Toole, commissioners; George W. Foster, treasurer, R. J. Cunningham, controller. City of Pittsburgh: Hon. W. A. Magee, mayor; E. V. Babcock, J. M. Goehring, J. P. Kerr, W. A. Hoeveler, Robert Garland, William C. Wilkins, Dr. S. S. Woodburn, and J. P. McGargle, councilmen; Wm. H. Davis, postmaster; F. R. Babcock, president chamber of commerce.

West Virginia.—Gov. William E. Glasscock, Morgantown; D. B. Regen, assistant field geologist, Morgantown; C. E. Krebbs, assistant geologist, Charleston.

STATE MINE INSPECTORS.

Alabama.—Chas. H. Nesbitt, Birmingham.
Colorado.—James H. Dalrymple, New Castle.
Idaho.—F. Cushing Moore, Boise.

Illinois.—Oscar Cartlidge, Benton; Thomas Lawless, Springfield; Thomas Little, Murphysboro; Hector McAllister, Streator; Walton Rutledge, Alton; W. W. Williams, Litchfield.

Indiana.—F. I. Pearce, chief inspector, Indianapolis.

Iowa.—J. E. Jeffries, Albia; R. T. Rhys, Ottumwa; Edward Sweeney, Des Moines.

Kentucky.—C. J. Norwood, chief inspector, Lexington; T. J. Barr, Lexington; H. D. Jones, Central City.

Maryland.—John H. Donahue, Frostburg.

Michigan.—John T. Quine, Ishpeming; W. C. Trestrail, Iron Mountain.

Minnesota.—P. L. Ramquist, Coleraine.

Nevada.—Ed Ryan, Carson City.

New York.—Wm. W. Jones, 14 Manning Square, Albany.

Ohio—George Harrison, chief inspector, Columbus; Edward Kennedy, Carbon Hill; John Burke, Wellston; Isaac Hill, Zanesville; Abel Elwood, Cambridge; Alex Smith, New Philadelphia; L. D. Devore, route 2, Bellaire; James Hennessy, Barton; Lot Jenkins, Martins Ferry; John L. McDonald, Glouster; W. H. Miller, Massillon; Thos. Morrison, Sherrodsville; Robt. S. Wheatley, Salineville.

Oklahoma.—Ed Boyle, chief inspector, McAlester; Martin Clark, McAlester; Frank Haley, McAlester.

Pennsylvania.—James E. Roderick, chief of department of mines, Harrisburg; Frank Hall, deputy chief, Harrisburg; T. K. Adams, Mercer; John F. Bell, Dravosburg; M. J. Brennan, Pottsville; D. R. Blower, Scottdale; C. P. Byrne, Punxsutawney; John E. Curran, Pottsville; F. W. Cunningham, Charleroi; Isaac M. Davies, Lansford; B. I. Evans, Mount Carmel; L. M. Evans, Scranton; Nicholas Evans, Johnstown; Thomas A. Furniss, Punxsutawney; W. H. Howarth, Brownsville; Joseph Krapper, Phillipsburg; A. B. Lauch, Shenandoah; T. S. Lowther, Punxsutawney; Alexander McCouch, Monongahela; Augustus McDade, Redham; C. P. McGregor, Carnegie; Alva May, Punxsutawney; Richard Maize, Somerset; P. J. Moore, Carbondale; T. A. Mather, Tyrone; Arthur Neale, Irwin; James A. O'Donnell, Centralia; Elias Phillips, Dubois; S. J. Phillips, Scranton; J. I. Pratt, Pittsburgh; Charles J. Price, Lykens; T. H. Price, Wilkes-Barre; C. B. Ross, Greensburg; I. G. Roby, Uniontown; D. J. Roderick, Hazelton; P. J. Walsh, Connellsville; Jos. J. Walsh, Nanticoke; Jos. Williams, Altoona; T. D. Williams, Johnstown; T. J. Williams, Kingston; David Young, Freeport.

Tennessee.—Geo. E. Sylvester, chief inspector, Nashville; John Rose, Dayton.

Washington.—D. C. Botting, chief inspector, Seattle; John J. Corey, Seattle.

West Virginia.—John Laing, chief inspector, Charleston; P. A. Grady, Williamson; E. A. Henry, Clifton; B. H. Hill, Chelyan; L. B. Holliday, Beckley; James Martin, Charleston; Arthur Mitchell, Bluefield; R. Y. Muir, Prince; Wm. Nicholson, Bluefield; W. D. Plaster, Elkins; F. E. Parsons, Clarksburg; Karl F. Schoew, Fairmount; L. D. Vaughn, Grafton.

REPRESENTATIVES OF MINING COMPANIES.

Abrams Creek Coal & Coke Co., Piedmont, W. Va.: A. Spates Brady, general manager.

Acme Coal Mining Co., Greensburg, Pa.: J. B. Huff, general manager.

Alden Coal Co., Alden, Pa.: K. M. Smith, general manager.

Allegheny Coal Co., Cheswick, Pa.: P. Townsend, manager; Jas. Adamson, superintendent; T. C. Singleton, foreman.

Allegheny River Mining Co., Kittanning, Pa.: D. C. Morgan, president; T. J. Williams, superintendent, Tidal mines; Arthur White, superintendent, Oakland mines; Arnold Hirst, superintendent, Conifer mines; Fred Norman, chief engineer; John Chilcott, superintendent of development; Dr. B. J. Longwell, chief surgeon.

Argyle Coal Co., Greensburg, Pa.: J. A. Dunsmore, superintendent; Ralph Pratt, foreman.

Bear Rock Coal Co., Lilly, Pa.: John Muldoon, foreman.

Beaver Valley Coal Co., Baltimore, Md.: Jno. T. Evans, superintendent.

Belle Valley Coal Mining Co., Cambridge, Ohio: J. H. Opperman, president.

Berwind-White Coal Mining Co., Windber, Pa.: Walter R. Calverley, general superintendent; James Wood, superintendent, Horatio, Pa.; Robert S. Baylor, superintendent, Windber; M. Robertson, foreman, Eureka No. 37, Scalp level; Albert Phillips, foreman, Eureka No. 30, Scalp level; John Fyfe, foreman, Eureka No. 31, Windber; James Sharp, foreman, Eureka No. 32, Windber; E. E. Higgins, foreman, Eureka No. 34, Scalp level; Smith Hawxby, foreman, Eureka No. 35, Windber; Benj. Davis, foreman, Eureka No. 36, Windber; Frank Boyd, foreman, Eureka No. 39, Seanor; J. S. Gill, foreman, Eureka No. 40, Scalp level; Wm. Fleming, foreman, Eureka No. 42, Windber; Clyde Macdonald, foreman, Eureka No. 35½, Windber.

Bessemer Coal & Coke Co., Russellton, Pa.; F. S. Love, general superintendent; W. P. Clark, mining engineer; T. A. Jackson, foreman; N. S. Beal, foreman; E. Mills, assistant foreman; James Thompson, fire boss.

Bessemer Coal Co., Masontown, Pa.; P. Lowther, foreman.

Blaine Coal Co., Elizabeth, Pa.; J. Clark, superintendent; A. O. Draper, foreman; J. F. Suffolck, fire boss.

Borderland Coal Co., Borderland, W. Va.: L. E. Armentrout, manager.

Brier Hill Coke Co., Brier Hill, Pa.: Thomas McCaffrey, general manager.

Buffalo & Susquehanna Coal & Coke Co., Dubois, Pa.: J. R. Caseley, general agent; J. Harvey, general superintendent; A. R. Darlow, mining engineer; H. A. Moulder, superintendent; Wm. Chick, superintendent; Jos. Bogle, fire boss; D. Ewing, fire boss; James Ewing, fire boss; R. K. Mead, M. D.; S. M. Davenport, M. D.

Bush Button Coal Co., Wellsburg, W. Va.: J. S. Braddock, president.

Cambria Fuel Co., Cambria, Wyo.: Lewis T. Wolle, vice president.

Cambria Steel Co., mining department, Johnstown, Pa.: H. C. Wolle, general superintendent; M. G. Moore, superintendent; G. T. Robinson, superintendent; J. M. Cook, assistant superintendent; J. J. Stoker, inspector; A. J. Dillenbeck, assistant engineer; C. E. Davies, foreman.

Cambridge Collieries Co.: W. H. Davis, electrical engineer; W. M. Bomesberger, electrical engineer.

Carbon Coal & Coke Co., Dudley, Pa.: Daniel Ryan, general superintendent; E. Donaldson, foreman.

Cardiff Coal Co., Greensburg, Pa.: James Walker, superintendent.

Carnegie Coal Co., Carnegie, Pa.: R. B. Burgan, president; J. T. M. Stoneroad, treasurer; T. D. Cribbs, superintendent; T. S. Smith, foreman; Joseph Linden, foreman; Archie Robison, foreman; George Smith, assistant foreman

Carrolton Coal Co., St. Benedict, Pa.: J. W. Haddick, foreman; G. Lennox, foreman.

Cascade Coal & Coke Co., Sykesville, Pa.: C. C. Gadd, general superintendent.

Century Coke Co., Brownsville, Pa.: C. E. Lenhart, president; D. C. Sheets, superintendent; T. H. Harris, foreman.

Cherokee & Pittsburg Coal & Mining Co., Frontenac, Kans.: Joseph Fletcher, general superintendent.

Chicago & Carterville Coal Co., Herrin, Ill.: J. D. Peters, vice president and general manager.

Chicago, Wilmington & Vermilion Coal Co., Streator, Ill.: C. A. Hubert, general superintendent.

Clark Bros. Coal Mining Co., Smoke Run, Pa.: J. H. Miller, superintendent.

Clark Coal & Coke Co., Peoria, Ill.: Horace Clark, general manager.

Clearfield Bituminous Coal Corporation, Clymer, Pa.: James Methvan, superintendent; D. J. Price, resident engineer; H. H. Hetrick, foreman; David Baird, foreman; Timothy McCarthy, foreman; William Leadhiter, foreman; William M. Evans, M. D.

Cleveland Cliffs Iron Co., Ishpeming, Mich.: W. Combuor, safety inspector.

Cochran Coal Co., Salina, Pa.: R. T. S. Steele, treasurer; W. H. H. Miller, superintendent; Thomas Stratton, foreman.

Colorado Fuel & Iron Co., Pueblo, Colo.: E. H. Weitzel, manager, J. C. Davidson, foreman; G. B. Parker, foreman; B. F. Pollard, foreman.

Commercial Coal Co., Bracken, Pa.: John Hammond, foreman.

Commercial Coal Mining Co., Expedit, Pa.: W. C. Smith, superintendent; H. P. Dingwall, electrical engineer; W. C. Harrison, foreman; B. F. Smith, clerk; Victor Bergh.

Connell Anthracite Coal Co., Scranton, Pa.: W. L. Connell, president.

Connellsville Central Coke Co., Uniontown, Pa.: C. E. Brotz, superintendent.

Consolidation Coal Co., Baltimore, Md.: A. T. Watson, purchasing agent; J. C. Gaskill, assistant consulting engineer; and E. Drennen, superintendent power and mechanical department, Fairmont, W. Va.; F. R. Lyon, manager Pennsylvania division, Somerset, Pa. West Virginia division—H. H. Watson, manager; C. H. Tarleton, superintendent of mining; E. B. Moore, chief engineer; A. W. Hesse, assistant chief engineer; and F. K. Day, L. A. Riggs, and E. S. Bonnet, division engineers, Fairmont, W. Va.; G. J. Altstetter, division engineer, Clarksburg, W. Va.; G. E. Peddicord, Monongah, W. Va.; Luke Murray, Glenn Falls, W. Va.; K. D. Bailey, Hutchinson, W. Va.; C. E. Gaskill, Adamston, W. Va.; H. M. Smith, Montana, W. Va.; and G. M. Gillette, Acosta, Pa., superintendents. H. S. Bell, gas inspector, Fairmont, W. Va.; J. C. Thompson, mine inspector, Watson, W. Va. Maryland division—H. V. Hesse, manager; D. G. Morgan, mine inspector; Daniel Porter, mine foreman; and A. W. Jenkins, assistant mine foreman, Frostburg, Md.

Consolidated Coal Co., Saginaw, Mich.: Alexander Liddle, superintendent.

Cortez Coal Co., Punxsutawney, Pa.: R. Hampson, superintendent.

Cowanshannock Coal & Coke Co., Yatesboro, Pa.: J. Craig, superintendent; A. Pryde, assistant superintendent; Charles Facemeyer, foreman; William Smith, foreman.

Crescent Coal & Coke Co., Pittsburgh: S. A. Taylor, president.

Cunningham Coal Co., Chicora, Pa.: P. A. Jordan, superintendent.

Davis Coal & Coke Co., Thomas, W. Va.: Lee Ott, general superintendent; O. Tibbetts, superintendent, Potomac Plant; P. J. Brennan, superintendent, Coketon Plant; W. W. Brewer, superintendent, Weaver Plant.

Dayton Coal & Iron Co., Dayton, Ohio: L. C. Crewe, general superintendent; W. N. Holden, superintendent.

Delaware, Lackawanna & Western Railroad Co., Scranton, Pa.: C. E. Tobey, assistant general superintendent; H. G. Davis, district superintendent; Walter Reese, district superintendent; P. H. Devers, assistant district superintendent; W. F. Sekol, mining engineer; R. L. Evans, foreman; J. A. Thomas, rescue foreman; Dr. D. H. Lake.

Dents Run Mining Co., Dents Run, Pa.: T. Y. Evans, superintendent.

Diamond Coal Mining Co., Rimersburg, Pa.: James Maloney, superintendent.

Dixon Coal Co., Idamar, Pa.: J. W. Harrison, superintendent; James Logan, foreman.

Dominion Coal Co. (Ltd.), Glace Bay, Nova Scotia, Canada: James McMahon, superintendent of rescue work.

Dunbar Furnace Co., Dunbar, Pa.: Stuart B. Marshall, general superintendent; J. W. Greaves, sr., superintendent; J. T. Bradley, foreman; John Stannis, James Paisley, fire bosses.

E. Eichelberger & Son, Six Mile Run, Pa.: Wm. E. Williams, superintendent.

Ellsworth Collieries Co., Ellsworth, Pa.: W. A. Luce, assistant general manager; F. B. Dunbar, superintendent, Ellsworth Plant; W. E. Lahson, superintendent, Cokeburg Plant; J. P. Miller, inspector.

Fayette Coal Co., Noblestown, Pa.: John McVickar, general superintendent.

Fayette Coke Co., Uniontown, Pa.: G. H. Reynolds, superintendent; C. E. Lenhart, general manager.

Franklin Coke Co., Uniontown, Pa.: J. S. Braddock, president.

Great Lakes Coal Co., Kaylor, Pa.: J. P. McCune, superintendent; P. U. Kelly, assistant superintendent; H. Muir, foreman; C. B. Henry, foreman; A. C. Shaffer, foreman; Thomas Page, foreman; David Jones, C. E. Johnson, fire bosses.

Greenwich Coal & Coke Co., Greensburg, Pa.: J. G. Dunsmore, superintendent; Martin Mairn, foreman.

Harbison-Walker Refractories, Pittsburgh, Pa.: J. J. Brooks, jr., general sales agent; Hay Walker, vice president.

Hastings Coal & Coke Co., Cherry Tree, Pa.: John Auld, jr., foreman.

Hazel Mountain Coal Co., Hazelton, Pa.: M. H. McTurk, assistant superintendent.

Hillsdale Coal & Coke Co., Glen Campbell, Pa.: Levi Connor, superintendent; John Wright, foreman.

Hillside Erie Co., Forest City, Pa.: Peter Parry, foreman; Alfred Bailey, G. E. Masey, assistant foremen.

Hudson Coal Co., Deerfield, Ohio: John P. Williams, superintendent.

Huff Coal Co., Humbert, Pa.: I. T. Huff, superintendent.

Hutchison Coal Co., Fairmont, W. Va.: C. J. Ryan, general superintendent; J. A. Jenkins, superintendent; C. D. Kramer, superintendent; Earl McConaghey, superintendent; E. P. McOlven, superintendent; J. Reuter, superintendent; F. R. Gerchow, chief engineer; J. F. Bratt, inspector; John Dailey, foreman; P. Costello, foreman.

Illinois Coal Operators' Association, Chicago, Ill.: Horace Clark, secretary; J. D. Peters, Carbondale, Ill.; C. A. Herbert, Streator, Ill.; W. J. Spencer, Canton, Ill.

Industrial Coal Co, Hilliard, Pa.: Edwin Greenough, superintendent.

Jefferson Coal & Iron Co., Livermore, Pa.: John Reed, general manager.

Kaine & Wilkey Coke Co., Uniontown, Pa.: W. H. Wilkey, manager.

Kemmerer Coal Co., Kemmerer, Wyo.: M. S. Kemmerer, president; P. J. Quealy, vice president and general manager.

Keystone Coal & Coke Co., Greensburg, Pa.: H. F. Bovard, general super~~intendent; Lloyd Huff, general manager; Frank Miller, assistant general man~~ager; G. W. Hutchison, chief engineer; G. H. Francis, engineer; A. N. Pershing, auditor; Wm. Nesbit, inspector; E. C. Taylor, superintendent; Foster Cook, superintendent; A. W. White, superintendent; Joseph Wentling, superintendent; H. H. Null, superintendent; Henry Welty, superintendent; M. R. Morris, superintendent; Alex. Coulter, superintendent; H. T. Knight, superintendent; James Duncan, foreman.

Knickerbocker Smokeless Coal Co., Hooversville, Pa.: T. Lewis, general manager.

The L. & H. Coal Co., Athens, Ohio: A. J. Laverty, president.

LaBelle Coal Co., Wellsburg, W. Va.: P. M. Scott, president.

Langdon Coal Co., Huntingdon, Pa.: C. J. Langdon, general manager.

Latrobe Coal Co., Latrobe, Pa.: D. W. Jones, superintendent.

Latrobe-Connellsville Coal & Coke Co., Latrobe, Pa.: M. W. Saxman, treasurer and general manager; J. F. Chrow, Earl Saxman, H. E. Rinehart, Thomas Fish, A. Smith, H. C. Cooney, W. S. Gibson, superintendents; C. L. Palmer, chief engineer; D. Connelly, Thomas Boyle, Martin Smith, James McGinnis, George Nishm, John McPherson, E. W. Altman, James Turnbull, foremen; C. Caldwell, John Hauser, A. Anderson, fire bosses; D. B. Clark, E. Ferry, M. Silk, James McCready, F. Hebner, J. Kattana, employees.

Leechburg Coal & Coke Co., Leechburg, Pa.: William Hodges, foreman; A. Morris, fire boss.

Lehigh Coal & Navigation Co., Lansford, Pa.: W. A. Lathrop, president; R. H. Wilbur, vice president; B. Snyder, jr., general superintendent; W. G. Whilden, superintendent; John L. Simons, inspector; B. Cunningham, fire boss; Dr. J. H. Young, Dr. E. H. Kistler.

Lehigh & Wilkes-Barre Coal Co., Wilkes-Barre, Pa.: D. R. Roberts, inside superintendent; Dr. F. L. McKee.

Lehigh Valley Coal Co., Wilkes-Barre, Pa.: S. D. Warriner, vice president and general manager; W. H. Davies, W. D. Owens, division superintendents; John Lloyd, inspector of equipment; Atherton Bowen, assistant inspector; G. T. Haldeman, mine-rescue engineer.

Locher Bros. Coal Co., Windber, Pa.: Thomas Locher, manager; T. MacTavish, foreman.

Louisville Coal & Coke Co., Goodwill, W. Va.: James Collins, manager; W. R. Dudley, chief engineer; G. R. Scott, superintendent.

Lower Vein Coal Co., Terre Haute, Ind.: George H. Richards, general manager.

Loyal Hanna Coal & Coke Co., Onnlinda, Pa.: Joseph Patterson, superintendent.

McAlpin Coal Co., McAlpin, W. Va.: William Laing, superintendent; P. B. Evindall, foreman.

McTurk Coal Co., Girardville, Pa.: W. R. McTurk, sr., president; W. R. McTurk, jr., assistant superintendent; J. M. Holt, superintendent.

Matthiessen & Hegeler Zinc Co., LaSalle, Ill.: James Cullen, William Koncewich.

Mifflin Coal Co., Pittsburgh, Pa.: J. M. Taylor, treasurer.

Monmouth Coal Co., Brereton, Ill.: W. J. Spencer, general manager.

Monongahela River Consolidated Coal & Coke Co., Pittsburgh, Pa.: G. F. Osler, general manager; F. J. Durdan, general agent; Richard Donaldson, sales agent.

Mountain Coal Co., Greensburg, Pa.: A. N. Pershing, assistant treasurer.

Myersdale Coal Co., Listie, Pa.: J. H. Seurfield, superintendent.

National Mining Co., Pittsburgh, Pa.: F. A. McDonald, chief engineer.

National Tube Co., Pittsburgh, Pa.: Andrew Teemer, traffic department.

~~New York & Cleveland Gas Coal Co., Pittsburgh, Pa.: Hugh Dunning, general~~ superintendent.

Nineveh Coal & Coke Co., Greensburg, Pa.: A. N. Pershing, assistant to the treasurer.

Northwestern Mining & Exchange Co., Dubois, Pa.: J. H. Fulford, general superintendent.

Oak Ridge Mining Co., Oak Ridge Pa.: H. Williams, superintendent; T. White, foreman; G. R. Williams, fireman.

Oliver & Snyder Steel Co., Uniontown, Pa.: Frederick C. Keighley, general superintendent; J. H. Lane, superintendent.

Paint Creek Collieries Co., Mucklow, W. Va.: W. L. Connell, president; A. H. Hale, general manager; J. A. Greene, superintendent; J. F. Hale, superintendent; E. M. Johnson, mechanical engineer.

Parrish Coal Co., Plymouth, Pa.: George O. Thomas, general foreman; Thomas G. Maggs, electrician; John Metal, engineer; Harry Trebilcox, fireman; Samuel Valentine, supply clerk; William J. Jones, bratticeman; David J. Williams, supply clerk; Edward Loughlin.

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Pittsburgh Coal Co., Pittsburgh, Pa.: W. K. Field, president; M. H. Taylor, chairman board of directors; G. W. Schluederberg, general manager; C. W. Biggs, chief clerk; H. B. N. Loutlett, manager of mines; J. M. Armstrong, manager of mines; E. J. Taylor, chief engineer; Ernest Taylor, mechanical engineer; A. W. Patton, chief draftsman; John Britt, chief mine clerk; J. W. Byers, livestock agent; Doctors Brown, Cruikshank, Dague, Davis, Dickson, Douglas, Dutton, Folz, Heath, Hensel, Kennchen, Kirk, Lake, La Ross, McCullough, McGarvey, Mitchell, Newell, Patterson, Schuster, Taylor, Walker, Warner, and Williams; Superintendents William Blower, William Carter, Henry Cattley, Thomas Easton, William Ferguson, P. J. Garvey, Emil Gerry, James A. Gould, T. W. Gray, John Hauser, Matthew Herron, M. T. Jones, William Kelvington, W. H. Linsley, W. A. Lockhart, S. P. McCaffrey, Alexander McClymont, Samuel McKay, B. F. P. Mank, H. R. Miller, William Neil, James Porter, Samuel Pritchard, Edward Ryan, L. C. Sarver, F. A. Schulte, James M. Sloan, F. W. Stark, R. V. Smith, H. D. Thompson, Jules Waterloo, and Thomas Whiteman.

Pittsburg Coal Operators' Association, Pittsburgh, Pa.: S. A. Taylor, secretary.

Pittsburgh Plate Glass Co., Pittsburgh, Pa.: C. E. Craig, superintendent; V. L. Henry, engineer; W. H. Clark, chief clerk; F. P. Smith, electrician; James Craig, foreman; John Riley, assistant foreman; Harry Haslett, assistant foreman; J. V. McDonald, fire boss; R. P. Stark, weighmaster.

Pittsburg Terminal Railroad & Coal Co., Pittsburgh, Pa.: W. W. Keefer, president; William Mimford, jr., superintendent.

Penfield Coal & Coke Co., Penfield, Pa.: Le Roy Smith, general manager.

Penn-Mary Coal Co., Heilwood, Pa.: H. P. Dowler, general superintendent; Harry Kalloway, general foreman; Charles Ganoe, foreman.

Pennsylvania Coal Co., Scranton, Pa.: William W. Inglis, general superintendent; C. W. F. Neuffer, mining engineer; Dr. F. F. Arndt.

Pennsylvania Coal & Coke Co., Philadelphia, Pa.: Joseph Thorp, purchasing agent; J. P. Walter, division engineer; R. D. Mainwaring, superintendent.

Piedmont & Georges Creek Coal Co., Westernport, Md.: W. E. Brown, superintendent.

Pioneer Coal Co., Starford, Pa.: H. H. Hetrick, foreman.

Plymouth Coal Co., Wilkes-Barre, Pa.: T. R. Phillips, treasurer; G. S. Jones, superintendent; D. J. Morris, foreman; W. Arthur, assistant foreman.

Pocahontas Consolidated Collieries Co., Pocahontas, Va: James Elwood Jones, general manager; W. H. Walters, superintendent; Robert Wallace, inspector.

Portage Coal Mining Co., Portage, Pa.: H. A. Tompkins, president; D. Froggett, foreman; William Filer, foreman.

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Reading Iron Co., Somerset, Pa.: George J. Krebs, superintendent; Thomas Stakem, assistant superintendent.

Rock Island Coal Mining Co., Chicago, Ill.: Carl Scholz, president.

Republic Iron & Steel Co., Republic, Pa.: W. H. E. Royce, general superintendent; D. J. Twist, superintendent; W. A. Perry, superintendent; F. W. Newhall, chief engineer; Logan Ross, storekeeper; C. F. Mills, master mechanic; L. D. Titus, fire boss; Frank Kabulish, mechanic; John Laick, machine boss; Joseph Patterson, fire boss.

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Sanford Coal Co., Pittsburgh, Pa.: R. B. Burgan, treasurer; B. F. Tarr, superintendent; William Drennon, foreman.

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Shawmut Mining Co., St. Marys, Pa.: W. R. Craig, chief engineer; James Jones, superintendent; Hugh Reynolds, superintendent; James F. Beattie, superintendent; A. E. Caldwell, foreman.

Somerset Smokeless Coal Co., Boswell, Pa.: J. L. Jones, foreman.

Solvay Collieries Co., Syracuse, N. Y.: C. C. Wilcox, superintendent.

South Fayette Coke Co., McClellandtown, Pa.: J. W. Abraham, general manager; J. S. Connors, foreman.

Spring Valley Coal Mining Co., Spring Valley, Ill.: S. M. Dalzell, general manager.

Stag Canyon Fuel Co., Dawson, N. Mex.: Dr. James Hyde, president; T. H. O'Brien, general manager; Dr. F. C. Diver.

Stage & Son Coal Co., Claytonia, Pa.: James Welsh, superintendent.

Stearns Coal Co. (Ltd.), Stearns, Ky.: J. E. Butler, superintendent; G. M. Humble, engineer.

Sterling Coal Co. (Ltd.), Cleveland, Ohio: H. D. Hileman, general manager.

Sunday Creek Mining Co., Poston, Ohio: N. D. Monsarrat, second vice president; Field Scott, district superintendent; H. G. Salters, electrician; Ed. Call, H. Stewart, J. H. Taylor, fire bosses; H. Thiessen, John Frazer, W. Pritchard, J. J. Murray, foremen; G. W. Grimes, engineer; James Hughes, sighter; Thomas McHarg, night inspector; James Williams, boss driver.

Superior Fuel Co., Greensburg, Pa.: R. M. Goehring, assistant engineer.

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Jeffrey Manufacturing Co., Columbus, Ohio: C. E. Waxbon.

Macbeth, Evans Glass Co., Pittsburgh, Pa.: H. P. Fuller.

Marshall Foundry Co., Pittsburgh, Pa.: Richard Muse.

National Tube Co., Pittsburgh, Pa.: Andrew Temer.

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