MINE RESCUE WORK.

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In order to make coal mining what it is today, there has been a sacrifice of many human lives and the loss of millions of tons of coal. The indefinite continuence of these conditions would be most unfortunate. But coal-mining engineers are facing these problems seriously. Already the explosiveness of coal-dust has been demonstrated, methods of its control investigated, a list of permissible explosives has been published by the government, and a paper on some phase of the efforts now being made for the conservation of that greatest of all natural resources, human life, it is believed will be of value.

The investigations in this field are proceeding along two lines——the prevention of mine accidents, and the work of mine rescue. While the first is by far the most important problem, it is never-the-less apparent that calamities such as mine explosions and fires are of such frequent occurrence as to be a constant menace to the safety of the men of the mine. For these reasons the work of rescuing life and saving of property are urgent p present-day coal mining problems.

From 2000 to 4000 men are killed in the coal mines of the United States each year. Fatatities in our metal mines average from 500 to 1000 deaths annually. For every 1000 men employed in American coal mines, at least three miners are killed every twelve months. In most foreign countries about two men are killed each year for every 1000 employed. It should be remembered in this connection, however, that the American miner produces considerable more coal, per man, than does the miner in Europe. For this reason, if we figure our fatalities on a basis of tonnage produced, the figures for this country show up as well, or better, than the European statistics.

When an explosion or fire occurs in a coal mine , conditions are usually such as to require that the men entering the mine be protected by helmets, which must be supplied as quickly as

possible. It is therefore , necessary, both for the rescue and investigation work , that rescue stations should be within easy reach of each important coalfield or division of the field, so that the trained experts can reach and enter the mines promptly following the disaster. Were each mine in the country equipped with a complete rescue station and manned with a corps of trained rescuers, we would have ideal conditions for the recovery of life and the preservation of property after a calamity. But, unfortunately, these are quite expensive; equally unfortunately , the present selling price of coal is so low that the small margin of profit is already a matter of much concern, so, unless some remedy for this condition can be found, but few individual mine owners, I fear, would feel warranted in authorizing such an expenditure of money. In order to overcome this obstacle and still obtain the benefits of modern mine rescue methods, the suggestion of joint rescue stations, it is believed, should be of great value.

In general, by a joint rescue station is meant one designed and equipped for a particular group of mines; located centrally to each of such mines by natural or special transportation facilities, and financed either on a "per ton" or a "share and share alike" basis by each mine benefited. At such a station, at stated intervals, a squad of men from each mine could report for training in rescue methods under the direction of an experienced instructor, assisted if possible by a physician. From such stations the rescue paraphernalia could be quickly furnished in the event of a calamity befalling any mine of this group.

Breathing appliances were invented abroad and their use established there long before we in this country could recognize their value. But if we study the design and equipment of these foreign stations, we might be discouraged in an endeavor to copy them. Conditions abroad and in this country are entirely different; and valuable as is a study of foreign methods, we

could not afford the luxury of such structures as the Howe Bridge Station in England. There, are , however, certain requirements that must be followed in design. The station building should contain a gas-tight room, 40 feet long by 20 feet wide and 10 ft. high. The interior of this room should be fitted to resemble a mine, and to afford opportunity for the practicing miner to do work similar to that required in the event of an actual disaster. In a number of stations already built in this country, it has been the practice to divide this room longitudinally and to construct an over-cast on one side, the aim being to present a passageway about the room , the travel over which would represent the journey of a rescue party through the entries of a mine, This room should be furnished with mine props and a frame consisting of four pieces of 6 by 8 inch timbers joined together in the shape of a square and tied with two iron irons, in which props may be set and capped with wedges, also brattice cloth, stretchers, and a canvas dummy filled with sand and sawdust so as to weigh about 165 lbs. In order that men may gain confidence in working in the presence of gas, sulphur candles may be burned in this room to form choke-damp; charcoal may be fired in open salamanders yielding blackdamp; hydrogen disulphide may be generated producing stink-damp, or ordinary dense smoke may be obtained by burning dampened exelsior.

Adjoining the smoke room and separated from it by a glass partition should be an observation room where visitors may sit and view the work of the miners. Here, too, the instructor may observe and record the performance of each member of the rescue squad. In this room there should be wall cases in which rescue apparatus may be hung and protected from dust; there should be work benches to facilitate the work of cleaning the instruments and the charging of electric safety lamps; and a place to store the cases in which the apparatus is shipped.

Back of the smoke room there should be a lavatory containing toilet, showerbaths and lockers for the accommodation of the miners

coming to the station for practice.

The equipment of the station should include: oxygen helmets, or other suitable breathing appliance furnishing a dependable supply of pure air, with the aid of which men may enter any kind of the foulest and most poisonous atmosphere in order to perform rescue work.

Apparatus and supplies for recharging these machines.

Portable electric safety lamps with a convient device for recharging.

A supply of some standard make of oil-burning safety lamps.

One or more resuscitating cases for use in reviving men overcome by the after-damp of mine fires or explosions.

Special cases or trunks, of convient size for handling, in which the above apparatus may be quickly packed and safely transported to the scene of the accident.

Next to be considered is the character of the training giving at the station. The training should include a general study of the conditions that obtain during and after a mine fire or explosion, with special detailed reference to concrete cases. With these actual occurrences in mind, plans should be discussed for successfully solving these problems according to modern rescue practice. The principles on which the machines used at the station are constructed and operate should be explained; and a thorough first-hand knowledge of the manipulation of the various parts should be acquired by the practicing miner. The actual training of the mind and body to do work similar to that required in the actual recovery of a miner and in the presence of deadly gases should be given by means of drills in the smoke room. In this way, men become acquainted with the possibilities of the machines, gain knowledge as to their own powers as rescuers, and learn to work in squads under the leadership of one of their comrades. For mental and physical ability shown

in the work, a certificate of competency should be awarded. This would tend to keep up interest in the work of the station, and be of especial value as a reference card when a disaster comes.

The general advantages that would be obtained from such stations are in a large measure obvious. It is often in an explosion that the ventilating machinery is thrown out of commission or totally destroyed. Also it is often necessary after a gas explosion to stop the fan to prevent a series of subsequent blasts and to control the fire by cutting off all ventilation. Previous rescue methods have afforded only a choice between two evils; either close the mine with concrete stoppings and leave it sealed indefinately, or start the fan , send in the men and trust to luck, with the result of the loss of many lives and much property.

With the introduction of modern practice, however, rescue work assumes a decidely different aspect. With the aid of the breathing appliances, trained men may enter the mine at once with comparative safety and begin the task of recovery, without aid of air supply from the fan. As the work progresses, each step may be taken with a complete knowledge of the situation gained by the careful reconnaissance of the helmet men.

Not least among the advantages that would accue from the employment of rescue stations, is that in cases of emergency there would be available squads of men trained for the undertaking, accustomed to working together and obedient to the commands of their leader.

A further advantage is that such rescue stations may become centers for the dissemination of knowledge among the men. In addition to the usual studies and lectures, local institutes could hold their own meetings in the observation hall of the station; and talks and demonstrations on first aid work could be given by the town or company physician with a view to forming

first-aid corps.

Much activity has been evinced by coal operators in the United States, aided by the Federal Bureau of Mines, toward the development of correct methods for rescue work and the proper establishment of rescue stations. For this work, we have called to our aid every contrivance or machine that has merit. Probably the most important part of this rescue equipment are self-contained breathing apparatus and the machines for reviving those who have been overcome by gases. The first breathing apparatus to be introduced into this country was of what is known as the Draeger type. Following the Draeger has come the Westfalia and the Proto. The Draeger and the Westfalia are German products, while the Proto is manufactured in England. German collieries are equipped almost entirely with the Westfalia and Draeger type, while these two with the Proto and a machine known as the Weg, command the market in Great Britain. Some of the French collieries use one of the German types, but principally are equipped with the Tissot, a machine manufactured in France.

To the Federal Bureau of Mines is largely due the credit of bringing into this country other types of rescue and reviving apparatus than the first styles introduced, thus starting a healthy competition and saving mine operators hundreds of dollars, besides encourging invention. In the early stages of the business it was the general policy of those selling breathing apparatus to obtain as high a price for each machine as the mine operator would be willing to pay. Such conditions are now changed and apparatus can be purchased in this country (as they come in duty free) almost as cheap as they can be bought in Europe near their point of manfacture.

A general campaign of educational work among the miners is now being conducted by the Bureau of Mines. Not only are the men taught the use of the rescue apparatus, but also the proper

way to take care of an injured miner. There will be littla excuse for the miner not benefiting through this free instruction, for the mine rescue cars will go to the miner in his own town or camp. Every effort is being made to encourage the miner to form rescue corps at the mines where they are employed, and to have the operators equip them with rescue apparatus.

Each rescue car contains eight so called oxygen helmets, a supply of oxygen in tanks, safety lamps, a field telephone, resuscitating outfits,etc. One end of each car is fitted up as an air-tight room, to be employed in training the men in the use of the breathing apparatus. This room will be filled with noxious fumes, and the miners will remain inside for two hours in an atmosphere that would kill without the breathing apparatus.

The saying that "prevention is better than cure" is equally true in coal mining and operators should first adopt all precautious that tend to make their mines safe; however recent experiences have proved that the human factor cannot be eliminated, and, consequently, the recovery of men and mine after an accident is a most important work.

Of equal importance with the work of the Bureau of Mines are the arrangements which the American Red Cross has made for the general instruction of miners in first-aid work. The object of the Red Cross in all its work is purely altruistic, and the society does not desire profit from it. The Red Cross has recently arranged to have a field agent continually in one of the mining districts, and a car has been provided to be used in carrying knowledge of first-aid and rescue work through our country.

Up until recently,many engineers looked upon the various types of breathing apparatus with apprehension, but actual services performed under trying conditions, especially in European mines, have largely removed this fear. Although there will be important changes and many improvements as time goes on and experience accumulates, it is, however, a fact, that in the hands

of a careful and experienced operator the present form of rescue apparatus is safe and efficient in a great majority of instances.

The early types of portable rescue apparatus bear small resemblance to the present day form. Probably the greatest difficulty was experienced in preparing a regenerator, the chemical action of which would provide for the perfect absorption of carbon dioxide, and at the same time, maintain a temperature sufficiently low to cause no discomfort to the wearer. In the early types a fluid solution containing caustic potash was used. The danger in this case was in the wearers inability to regulate the flow of oxygen. Then came a machine having a regenerator which had to be prepared at the time the apparatus was to be used; this plan was unsatisfactory because such an apparatus should be immediately available. After further years of experimenting, the present type of apparatus was designed; this machine has a regenerator, the absorption power of which is constant and which regenerator is ready for immediate use upon breaking the seal that contains. Sufficient absorptive surface was provided so that a cooler could be dispensed with , and the present type of cylindrical oxygen bottle was adopted.

Liquid oxygen has also been tried to supply the oxygen needed in the helmets or mouth pieces and is very efficient but the difficulty lay in procuring a sufficient amount of liquid oxygen.

The Aerolith Rescue Apparatus uses liquid-air for breathing purposes and its one great feature is that it is only about one-half the weight of the other types.

There are many points to be considered in the selection of a breathing apparatus. The first problem is to decide whether the helmet or the mouth-piece type is to be used. The helmet type was first introduced in this country and was looked upon with great favor by the early experimenters. Years of tests in European stations and mines have caused the operators to revise their early opinions and look with equal favor upon the mouth-

piece machine. This latter type of apparatus is in high esteem abroad and is now used in great numbers.

The helmet type is excellent for practices purposes in a gallery, but the mouth-piece machine (according to statistics), is safer and possesses greater merit for use after a mine disaster in a poisonous atmosphere where the temperature is high. One great point favoring the mouth-piece type is the fact that it allows the wearer free evaporation of body heat. Tests in this country are already bearing out the European idea that a man will be more comfortable with the mouth-piece type , after one or two hours service, than he will be with the helmet.

With the mouth-piece type of apparatus, it is a question as to the best method of stopping the nose. Each manufacturer has embodied his own ideas. The nose clip, which is somestimes used, is liable to be removed by sneezing, and aside from its general discomfort there is a considerable danger that it will lacerate the nose. The method of using cotton plugs dipped in vaseline and inserting these in the nostrils, afterward covering the nose by a leather guard, is a better plan. A speaking diaphragm should be attached to the mouth-piece to enable the wearer to carry on a conversation.

With a helmet type of machine, safety and efficiency largely depends upon having a tight and comfortable fit around the face. This difficulty is also met by the manufacturer in different ways. One type of machine uses an elastic face washer and supplements this with a pneumatic pad; another accepted type of machine depends entirely upon the inflatuation of pneumatic pads alone, for making the fit around the face and head. This latter type is slightly more dangerous than the plan of using an elastic face washer, because if the pneumatic pad becomes punctured, or leaks, and it is necessary to pump up from time to time, the wearer is pumping mine air into his own helmet. When the pneumatic pad is outside the face washer and a leak occurs, the air escapes outside.

Another point to be considered in the selection of a breathing apparatus is the weight of the machine. This is a matter of considerable moment, as the amount of work a man can do depends largely on the weight he has to carry. In this connection I want to say that the plan of sending two men equipped with breathing apparatus into a mine is neither safe nor sensible. In case one man goes down, or has an accident, the other rescuer can be of practically no service at all. A rescue apparatus weighs 40 or 50 lbs., and it impossible for one man already carrying his own machine to lift another man wearing a machine. To lighten the weight by taking the apparatus off the prostrate man would perhaps mean death immediately. A rescue party should never be composed of less than three men, and a still greater number is most desirable.

The types of resuscitating apparatus now on the market are known as the "Pulmotor" and the "Doctor Brat". Both of these apparatus are of great service when applied to persons who have been asphyxiated by gas, or over by smoke or water. The machines are also valuable for use in hospitals for extreme respiration. The "Pulmotor" is operated by clockwork, while the "Doctor Brat" apparatus is regulated, according to the needs of the patient by moving a lever which first exhausts the lungs and then injects oxygen. Each of the two systems has its own advocates, and both styles of apparatus has a commendable record for efficient service.

The common object of the various types of breathing apparatus is to enable the wearer to remain at work for varying periods of time in an atmosphere which is either deficient in oxygen or is poisonous like the after-damp of a coal mine explosion.

Commenting on recovery apparatus to be efficient, it must fulfil the following conditions:

1. It must be airtight as regards the passage of the air

from the outside to the inside. In atmosphere containing carbon dioxide a slight leak would not render the apparatus useless, but where irritating vapors, such as the smoke from burning sulphides, is met with, even the slightest leak must be avoided.

2. The oxygen supply must be ample, and so supplied that it is not checked by expiration.

3. Expiration and inspiration must not be retarded.

4. The carbon dioxide generated must be quickly and efficiently absorbed.

5. As salivation is much increased when wearing some types of breathing apparatus, effective saliva catches should be provided in order to prevent contamination of the inspiratory air.

6. The apparatus must not be too heavy, must not impede the wearer's movements, nor impair his powers of observation. Its volume should be such as to render it easy of transport in the workings of a mine.

Modern types are constructed on the following principals:

(a). The expiratory air is purified by the use of a chemical which absorbs the carbon dioxide and moisture exhaled.

(b). The oxygen consumed in breathing is replaced from reservoirs containing the gas in a compressed or liquid form, or from chemicals liberating oxygen by means of chemical reactions taking place during the use of the apparatus.

Breathing apparatus now fall under one or other of the following types:

1. A helmet through which a constant current of air is passed, either from a pump or from a compressed air main being connected with the helmet by a length of hose? or from a reservoir of compressed air carried by the wearer.

2. In this type the wearer breaths in and out of a bag provided with arrangements for absorbing the carbon dioxide and moisture, contained in the exhaled air, while highly compressed oxygen from steel reservoirs passing through suitable mechanical

arrangements replaces that comsumed by the wearer, and as far as possible, assists the wearer in the act of inspiration.

3. In the third type the exhaled air passes through a cylinder containing peroxide of sodium and potassium. These compounds not only absorb carbon dioxide, but theoretically liberate sufficient oxygen to make up for that used by the wearer.

4. In this type the oxygen is derived from the evaporation of liquid air.

It appears that there is a considerable time during which even men lying on the track of the explosion could be saved if only it were possible to protect them from the afterdamp. There are three possible ways of protecting the men from afterdamp. One is to get pure to them; another is to get them out of the afterdamp; and a third is to give them oxygen to breathe until they are in pure air again.

If in the first of these ways, the down-cast and up-cast shafts are close together, as is geaerally the case, separation doors and air crossings would be destroyed, so that fresh air could not be got around the pit in the ordinary way. The shafts, and a short distance from them, would, however, be swept by fresh air almost at once. Even if the fan had been injured, the warmer up-cast would indice a powerful air current, and it would probably be possible to descend the up-cast at once and rescue any men who were close to either shaft. If the working were connected with any other pit, it might be possible to clear out the afterdamp by sending men to open the communicating door, meanwhile covering up the top of the down-cast shaft with planks. Air would thus be drawn through the communicating door and main road towafd the up-cast; and the afterdamp would be expelled by the shortest route. It seems that this plan would be successful, as the track of the explosion would be cleared in a few minutes of the door being opened with the down-cast wholly or partially blocked.

If there are injured at the bottom of the down-cast, and no means of getting them out at the time, they might be kept in fresh air while the afterdamp is passing out. Wherever there are more than two shafts available, it ought to be possible to do something in this way, and with far greater prospects of success than by any other means. In most cases there are only two shafts close together, and the separation doors and any air crossings near the shaft are made so as to resist explosions or be capable of rapid repairs, the stagnant afterdamp would remain on the main roads or roads right up to within a short distance of the shaft. Rescue operations beyond this point would be thus impossible, or result disastrously, where no one knows how to test the air. If the main doors and air crossings are gone, every effort should be at once concentrated on repairing them and thus getting the air through the workings. The importance of getting this done in the quickest possible way is evidently very great, and as soon as the air begins to travel inward it should be followed up, particularly as fires might be discovered which might become dangerous unless dealt with promptly.

It might be found that the main road was so much blocked by falls, and in such a dangerous condition from the state of the roof, that there would be great difficulty in getting in, and attempts to bring injured men out at once would be almost hopeless. In such a case it might be very advantageous to work inward from the return side. For this purpose it would be desirable to reverse the ventilation, and the provision of means for doing so seems to me to be in any case advisable.

With a fire in the intake, following an explosion, reversal of the ventilation might of course, prove invaluable. If rescue apparatus and trained men are available, they can be sent at once into the poisonous air away from the shafts to explore, extinguish any fires, and render what aid they can.

Whether or not a rescue corps is available, it is usually much easier to get fresh air to the disabled men than to bring them out to fresh air. The main work of rescue will thus always consist in restoring the ventilation. The rescuers ought ot be provided with means for testing the air at any point, and for this purpose a bird or mouse, inclosed in a box, shutting air-tight, might be used, the box being capable of being connected to the exhaust of a rescue apparatus, so that the animal can be revived at once if necessary. A rescue corps might also be provided with subsidiary apparatus for fixing over the faces of the disabled men, and thus protecting them from afterdamp until they can be removed; but this matter has not as yet been properly considered.

In connection with all rescue work at explosions or fires, proper means of testing the air are, of course, very important. If nothing but a lamp is used, no one knows if the air is dangerous or not. Hence, much danger may be incurred, as was the case, for instance, with the Darran explosion. On the other hand, there may be much wholly unnecessary waste of time, or equally unnecessary ~~waste~~ reliance of rescue apparatus, which are a great hinderance when work can be done without them. If small birds or mice are used for testing, these risks and delays can be avoided.

Dealing with the question of rescue operations at underground fires it is held that in view of the dangers of a fire, means of reversing the ventilation ought to be provided at every mine. The subject was brought before the Mining Institute of Scotland many years ago by a Mr. Allardice, who introduced a very simple arrangement for reversing the ventilation at the colliery under his supervision. This method is extremely difficult. There were, however, other methods of attaining the same object. Failing the possibility of reversing the ventilation at once, or of cutting it off underground, the top of the

downcast shaft might be closed, so as to cut off the supply of air to the fire and the current of poisonous air around the mine.

This might seem a desperate measure to give both the men and mine a chance, than if the fire were simply allowed to burn on, and the smoke and the carbon dioxide to be carried around the workings. The flame would be quickly extinguished and the time might be gained for reversing the ventilation before all in the mine were dead. In such cases, the risk of a fire damp explosion on reversing the current would to be carefully considered and guarded against, however, and there are many mines where this risk would be far too great, so that direct reversal of the ventilation would be the only safe means. The ventilation might be reversed by turning water down the upcast shaft, and when once the current was turned, the hot air from the fire would pass into the downcast, and probly maintain the current in the right direction. Even so, the air would probably become explosive in many mines, so that nothing short of efficient reversal by fan ventilation would be at all safe. The distribution of the reversed air current would, of course, be very imperfect, but with proper care as regards the arrangement of the more important doors, a suffiently good distribution could be obtained to enable the men and the mine to be saved.

It is, of course, impossible to lay down any hard-and-fast rules as to what ought to be done in connections with rescue operations at explosions or fires, as the circumstances vary in every case, and nothing can replace individual intelligence and discussion on the part of the responsible officials.

The recovery of 20 living men from an improvised refuge chamber in the Cherry Mine, Illinois, one week after entombment awakened general interest in the systematic establishment of equipped refuge chambers in coal mines.

The employment of such chambers is by no means new. There have been a few well equipped refuge chambers established for years in certain mines abroad, and in at least one case in France.

have been of value in saying life. The great number of mine disasters in this country, as well as a large percentage of such accidents to the men employed in the mines, makes the question of refuge chambers a most important one for us to consider.

In a majority of the mine disasters that have occurred in this country since 1907, there have been men in certain portions of the afflicted mine who have not been killed outright and who, in some instances, have lived for a considerable time, even hours after the explosion. This was notably the case in the recent Primero (Colorado) mine explosion. At this mine, a branch explosive wave entered the first working entry on the left for about 1800 feet and then died away. Fifteen miners in their working places beyond the limit of the explosion were not injured by violence or flame. One of them was ultimately rescued about 12 hours after the explosion. He stated they wandered about for some hours trying to get out. In the last attempt they were overcome by the afterdamp and all but one died. It is evident that if they had remained in their places all in this party would have escaped.

Had there been a refuge chamber in the vicinity with telephone connections to the outside, there is little doubt, that these men would have gone there, and with good air and provisions, and encouragement by word from the outside, would have stayed in perfect safety. The rescue party would have had a definite place to work towards, and if necessary, have employed oxygen helmets to reach the entombed men.

Windber, Johnstown, Wehrum and Herrin can be cited among recent explosions, in which of the victims were lost by afterdamp.

To further the development of the investigations into the causes of mine explosions and to spread knowledge of modern methods of mine rescue work--there

methods of mine rescue work there have been established and now in operation under the U.S. Geological Survey and the Bureau of Mines, one Federal station at Pittsburg, Penn., and other branch stations have been established, accessible to the more important coal-fields of the United States. Each of these stations is supplied with such equipment as is needed by the government experts and their assistants in entering mines immediately following disasters for investigations, and which they have used incidentally in rescuing entombed miners and in determining when and how the mine ventilation could be restored, and general rescue work carried foward by local authorities.

At each of these stations a mining engineer has been placed with a limited amount of equipment, including oxygen helmets, necessary for the use of himself and assistants in entering mines, in part or entirely, filled with poisonous gases, as is usually the case immediately following a mine explosion. At each of these stations the mining engineer in charge has trained as volunteer assistants a limited number of young practical miners in the use of the special rescue apparatus, on condition that in case of a mine disaster occuring in that region each of these would accompany the Government expert and aid him in entering the mine immediately following the explosion for the purpose of examination into its causes and results. In carrying out this plan not only has valuable information been obtained, but a number of miners supposed to have been killed have been rescued, and subsequent explosions have been prevented beyond question or estimate the value of such work.

The majority of the investigations into the causes of mine explosions are being conducted at the Pittsburg mine- experiment station, this being not only the greatest coal mining center in the country, but the point nearest the largest number of mine disasters which have occurred within a few years previous to the inauguration of this work. The work now in progress here includes reserches in connection with the explosives used in mining, the

nature, extent, and behavior of the gas and dust found in coal mines, and other factors which are believed to be direct or indirect causes of mine explosions.

The investigations at Pittsburg have been supplemented as far as practicable by an examination into the local causes and attendent conditions of each of the coal mine disasters occuring in the United States during past years. But the long delay in reaching the majority of these mines from the Pittsburg station following the occurrence of these disasters was ~~to be~~ a serious handicap to the success of this work. With the view to lessening this difficulty as far as practicable, the branch stations were established.

The causes of certain mine accidents have been traced with a fair degree of ease and certainty to the improper use of explosives, open lights, to faulty electric equipment, to falls of roof, to lack of discipline,etc., but the larger mine disasters, involving gas or dust, or both, are still little understood, notwithstanding the investigations under way in this and other countries. Unfortunately in most such cases those who might have thrown light on the initial causes have not survived the disaster. In all cases the development of satisfactory preventive measures is still more difficult, and in this country has been long neglected, though equally deserving of inquiry and reserch of the widest scope and most thorough character.

The urgency of this work is further emphasized by the fact that as our coal mines are becoming deeper, the gas is becoming more abundant and the mines correspondingly more dangerous. The number of such disasters and the loss of life has been for some years steadily increasing. Furthermore, disasters have been occuring in regions where they were least expected and in the safest mines

The investigations authorized by Congress as to the cause of mine explosions are now under way, and the facts already developed are such as to encourage the belief that means of lessening disasters from such causes will be in hand in the near future