and an honor to us as Master Boiler Makers to have you address this meeting today. I am sure that everyone here will benefit greatly by your remarks, especially those suggestions that you have made to the Boiler Maker foreman, and I know that all of us will go home with a greater feeling of responsibility on our part. On behalf of the officers and members of the Master Boiler Makers' Association, I extend to you their thanks and appreciation.

Secretary Stiglmeier: Mr. President and Members: Sitting here today and listening to the message just presented to you gentlemen by our good friend Mr. Gangewere, it kind of brings me back to the correspondence I had with Mr. Gangewere. When I wrote him, extending invitation to address our Association, he wrote back and said that he would be glad to do it if I believed that he could give to you a message. The message he gave to you, I am quite sure is going to be of benefit.

Mr. Gangewere brought out to you a message similar to what you have in your program on Topic No. 4, "The Education and Training of Boiler Supervision" Both Mr. Gangewere and Mr. T. J. Lyon the Chairman of the Committee on Topic No. 4, in the important position these gentlemen hold, have the same idea in regard to the training of Education and Training of Boiler Supervision.

I am going to ask each one of you gentlemen as a favor, to take this program to your room tonight, study this report on Topic No. 4, and be prepared to discuss the same with Mr. Lyon when he presents the same to you at the meeting, I am quite confident that both Mr. Gangewere's message and Mr. Lyons's report on Topic No. 4, should be of benefit to all of you. It brings to you the fact that as Master Boiler Makers you not only have the Boiler Maker craft ahead of you, but if you will ask questions, similar to what Mr. Gangewere points out to you, and what Mr. Lyon presents in his paper. There is a brighter future for you, other than that as Master Boiler Makers, gentlemen, you don't have to fear the Diesel locomotive. So let's get busy and ask questions on your return home after these meetings, for there is a future for each one of you, as presented by Mr. Gangewere, and as will be called to your attention in the report on Topic No. 4

Thank you. (Applause)

President Heidel: Thank you, Mr. Stiglmeier.

We will take up next Topic No. 1 — "How Can the Master Boiler Maker Aid in Smoke Abatement and Fire Prevention?" Mr. E. H. Gilley, Chairman.

Mr. Gilley: Mr. President, Officers and Members of the Master Boiler Makers' Association: The subject which we have in Topic No. 1 is of very great importance both to us as Master Boiler Makers and to the Railroads by which we are employed. I believe that the subject of smoke abatement and fire prevention is one of the greatest and liveliest subjects which is before the Railroads today. We in this committee have endeavored to select members from various parts of the United States and Canada in which the smoke abatement problem has been serious, and the papers that have been prepared are quite lengthy and we do not have sufficient time to read each paper in its entirety Therefore, I am going to endeavor to pick out certain salient features or parts of the individual papers and go through them hurriedly so that we can have a good discussion on the subject.

. . . Mr. Gilley presented the highlights of the individual reports of the Committee covering Topic No. 1, printed in the Official Program . . .

Topic No. 1

HOW CAN THE MASTER BOILER MAKERS' AID IN SMOKE ABATEMENT AND FIRE PREVENTION

MR. E. H. GILLEY, *Chairman*, General Boiler Foreman
Grand Trunk Railway System

MR. H. C. HAVILAND, *Vice Chairman*, General Supv. Boilers
New York Central Railroad

MR. G. E. LAUDERBACH
Supervisor Power Plants
New York Central Railroad

MR. F. H. HEIGHLEY
Locomotive Inspector
Bureau of Locomotive Insp.
Interstate Commerce Commission

MR. J. J. DESMOND
Boiler Foreman
Washinton Terminal Co.

MR. D. P. VERNON
Boiler Foreman
Reading Company

MR. P. K. INGLE
Locomotive Insp.
Board of Transportation Commissioners for Canada

MR. S. A. FEGAN
District Boiler Inspector
Canadian National Rys.

MR. J. D. JOHNSON
Chief Boiler Insp.
Missouri Pacific Railroad

MR. G. T. SINGLETON
Boiler Foreman
Erie Railroad

MR. L. D. PRIOR, Regional Boiler Insp.
Baltimore & Ohio R. R.

To the Officers and Members of the Master Boiler Makers Association:

Your committee on topic number one "How Can the Master Boiler Makers Aid in Smoke Abatement and Fire Prevention" was selected from railroads operating in various parts of the United States and Canada in order that we might present to you the things that were being done by the various railroads in the abatement of smoke and prevention of fires, also other things that could be done along these lines that would have a considerable bearing on the subject of the topic.

To us as Master Boiler Makers the subject of Smoke Abatement and Fire Prevention is of the utmost importance, as with the trend to dieselization of our railroads, the steam power that will be retained in service will become less each year and it is our duty as Master Boiler Makers to maintain the remaining steam power to the highest degree of efficiency consistent with the requirements of the service to be performed.

The members of this committee have, in the papers submitted to you, given valuable information which I am sure can be utilized by each of you to its fullest extent. Smoke Abatement and Fire Prevention is a matter of maintenance of the equipment insofar as the Master Boiler Maker is concerned and I am sure that each of you here today have some methods of maintenance that will be of benefit to all of us in the Abatement of Smoke and Prevention of Fires, and, in the discussion period of this topic, we want you to get up and give us the benefit of your own experience, by doing this, we will gain knowledge from you just as you will gain knowledge from us.

by — Mr. Harry C. Haviland
Mr. George E. Lauderback

In recent years there has been a distinctly noticeable campaign, nation-wide in scope, toward smoke abatement.

Numerous municipalities, cities, and counties, have enacted or are about to enact ordinances for the control of smoke. The National Smoke Abatement Association of America, in their annual meetings are continually discussing this subject, and recommending various restrictive courses of action.

A great deal of newspaper and magazine publicity and propaganda, some sensational in character is devoted to the topic of smoke and smoke abatement.

One of the targets of this campaign is the steam locomotive. Although the fuel consumed by steam locomotives is only a small part of the national total, a disproportionate amount of criticism is directed towards the railroads by those responsible for the enforcement of smoke abatement ordinances. Smoke Abatement Engineers find it more convenient to exert pressure on a single railroad officer who may be in charge of several hundred locomotives, than to visit a large number of commercial establishments. Moreover, the super-salesman of Diesel Electric Locomotives utilize smoke elimination as one of their stock arguments. In addition, with the amount of power that has to be generated in the dimensional limitations imposed on the steam locomotive firebox, objectionable smoke can readily be produced by improper operation or result from insufficient maintenance.

The Master Boilermaker can make a most substantial contribution to the cause of smoke abatement by correctly maintaining the steam locomotive under his supervision. A freely steaming locomotive does not have to be forced and has little or no tendency to smoke.

On the other hand, a poorly steaming locomotive is likely to emit dense smoke particularly during capacity operation.

The causes of poor steaming is well known to Boilermakers; defective draft appliances, leaky superheater units, plugged flues, improperly maintained brick arches, etc., all interfere with free steaming. In considering the effects, that the above mentioned parts have on performance, it is useful to visualize the locomotive boiler as a convevor system for air and combustion gases, as for each pound of steam produced a definite weight of air must pass through the grates and a definite weight of combustion gases must be ejected from the stack. The air for combustion enters through the sides of the ash pan and passes up through the grates. These parts must be maintained to the required standard.

The brick arch, a most effective device for improving combustion and preventing smoke must be maintained in accordance with the established drawings. Every Boilermaker knows that an improperly applied or defective brick arch will adversely effect locomotive performance.

In recent years, the development of the Security Circulator and Thermic Syphon have afforded a stronger and more efficient brick arch.

All the combustion gases have to pass from the firebox to the front end through the flues. Because of the high gas velocity, flues must be kept open and clean. Plugged flues invariably cause poor steaming and dense smoke. Present authorities estimate that each square foot of flue cross sectional area enabled a production of 9,000 to 11,000 pounds of steam per hour.

Modern steam locomotives, are literally built around the superheater,

as superheated steam provides the necessary power and economy. It is generally recognized that the modern locomotive superheaters have made possible the capacity and efficiency of the modern steam locomotive. Because of their adverse effect on locomotive performance, superheater defects cannot be tolerated.

The front end draft appliances, move the combustion gases from the flues and discharge them to the atmosphere. In recent years, a great deal of successful research work has been done to increase the capacity of the draft appliances and to reduce the back pressure in the exhaust nozzle, thus making more power available for useful work. The draft appliances, nettings, exhaust nozzles and stack, should be maintained in accordance with the established standards and not altered by unauthorized individuals. The use of erosion resistant alloyed cast irons in the stack and stack extension pieces, have simplified the maintenance of these parts by extending their useful lives.

Also it would be well for the Master Boilermakers to keep himself thoroughly informed of the latest development and research in the drafting of locomotives, and to understand the fundamental principles thereof; as there is a considerable degree of misconception regarding the front end appliances.

Steam or water leaks should have no place in the locomotive picture. With present day maintenance methods they are unnecessary and are inexcusable. Modern methods of water treatment have, by keeping scale from firebox heating surface and flues, greatly improved heat transmission from the combustion gases to the boiler water. Thus, more steam is produced with lower firing rates and smoke due to excessive forcing of the boiler is thereby prevented. It is the Master Boiler Maker's responsibility to be certain that the water in the boiler of the locomotives under his supervision is properly conditioned. Zero hardness, correct values of alkalinity and of the dissolved solids, and blow down standards must be maintained. In the present state of the art of locomotive boiler water conditioning these things can all be done without difficulty.

Many locomotives have been fitted with various designs of smoke consumer equipment designed to admit over fire air, and to create turbulence in the firebox gases. Although, these devices are operated by others except when firing up, it is the boilermaker's responsibility to see that these devices are maintained in accordance with the established standards.

A great many of the complaints by Smoke Abatement Engineers are the results of improper firing up practices at locomotive terminals. These complaints are in many instances fully justified. By the exercise of proper forethought and judgment, improper firing up practices which lead to the emission of dense smoke may be eliminated.

The locomotive boiler must be properly prepared before firing up. The green coal must be spread evenly over the grates, and a hole left in the middle of the fuel bed to admit air to consume the gases distilling from the coal. A portable smoke consumer actuated by compressed air or steam may advantageously be utilized to control the smoke

In terminals where a direct steaming system is available, the locomotives may be brought up to or maintained at the working pressure without igniting the fire. Afterwards, when the fire is ignited, it may be allowed to burn through slowly with the smoke consumer in operation. It is not generally necessary to force the fires in such locomotives except for emergency dispatchments.

Most railroads have established rules and procedures pertaining to firing up practices, and these rules and procedures should be strictly complied

with by all Boilermakers. At locomotive terminals the use of stokers on locomotives so equipped should not be allowed.

Although the Master Boiler Maker is not directly concerned with the operation along the road, attention is directed to the part that smoke abatement enroute is largely a matter of educating the engine crews in proper firing practices and correct operation of the boiler feed water equipment.

Locomotives must not be overloaded if smoke is to be eliminated. The tonnage ratings of given locomotives are well known and well established. Many of us are aware of the disastrous effects of overloading Diesel Electric Locomotives, and the insistence of the manufacturers that overloading must not be permitted. When steam locomotives are overloaded, damage does not necessarily or usually result. However, the fires have to be forced well beyond the established limits of good firing practices, and the continued emission of dense smoke generally results.

The fuel utilized also has a direct bearing on the amount of smoke emitted. Numerous tests have shown that superior results are afforded if the coal utilized has all of the fine, less than ¾" screened out, before loading in the tender. Where screened coal is utilized, unburned cinder loss becomes very small, the fuel consumption is kept at a minimum and smoke emission materially decreased.

In addition to the sizing of the coal, attention must be given to the grade of coal furnished and their relationship to steaming and smoke emission.

The usual smoke ordinance contains clauses relating to the emission of smoke of certain density as measured by the "Ringelman Chart" and to maximum time limits. In recent years some ordinances have also included a clause relating to the direct loading and dust content of the combustion gases. It is generally recognized that the restrictions imposed by the terms of a smoke ordinance, must not be in advance of the "state of the art" of combustion engineering practices, otherwise they are disregarded as unworkable.

Modern mechanically fired stationary equipment can be made to comply with the terms of most smoke ordinances. However, difficulty is experienced with semi-mechanically or hand fired equipment and with steam locomotives.

Compliance with the direct loading provision is most difficult even for stationary equipment. As far as locomotive performance is concerned the restriction provided by the standard front end nettings are generally acceptable, and a literal interpretation would be beyond the "state of the art."

The control of smoke in stationary equipment is primarily a function of design and method of firing. Modern installations are usually provided with some form of mechanical firing equipment, regulated by automatic controls and having adequate furnace volume. With modern mechanical oil burners, single or multiple retort under feed stokers or pulverized coal burners, almost no difficulty is experienced in continually maintaining clear stacks as far as smoke is concerned.

Certain types of spreader stokers oft times produce large quantities of pernicious fly ash and cinders, the emission of which constitutes a nuisance, unless dust collection and recovery equipment are installed.

In semi-modern installations with under feed, over feed, or chain grate stokers, there is difficulty in controlling the smoke in many instances because of insufficient furnace volume and also at the time of cleaning fires. Occasionally, one finds a semi-modern pulverized coal installation with insufficient furnace volume and having a tendency to smoke.

Compliance with the usual terms of smoke ordinances ordinarily entails no difficulty with properly resigned modern or semi-modern equipment. In the event of difficulty with modern equipment, it is usually possible to attain compliance by minor changes in construction or operation. If an ordinance contains unduly restrictive provisions regarding the dust loading of chimney gases, however, compliance therewith may entail the installation of dust collection equipment high in first costs and expensive to operate and maintain when pulverized coal, forced draft, chain grate stokers, or under feed stokers at high ratings comprise the firing equipment. In the event of spreader stokers being utilized as the firing equipment, it is, of course, understood before hand that dust collection equipment is necessary.

In hand fired installations, all of which may be considered obsolete in any size from 100 horsepower up, difficulty is almost invariably experienced in controlling the smoke. This is an inherent characteristic of hand firing; as in contradiction to mechanical firing, the fuel air ratio cannot be kept reasonably constant but is necessarily variable. The use of over fire air jets is found to be reasonably effective in abating the smoke from these units. To be fully effective, however, the amount of air in use by the jets is so large that a loss in efficiency results. When hand fired are operated at high ratings, the over fire air jets are unable to completely eliminate the smoke.

At the present day cost of coal, the investment incident to the replacement of hand firing with some sort of mechanical firing will be rapidly liquidated by the saving in fuel. Therefore, all hand fired installations should be regarded as candidates for replacement by mechanically fired units, not only in the interest of smoke abatement but of economy as well.

The Master Boiler Makers must be actively concerned with the subject of fire protection.

The subject can be divided into two phases. Fires along the right-of-way, and fires at locomotive terminals and repair shops.

As indicated by extensive literature a relatively enormous amount of investigation has been devoted to fires along the right-of-way allegedly caused by sparks and burning cinders said to have been emitted from the stacks and ash pans of steam locomotives. Even to this day, some railroads report difficulties from this source. In the remote past, when the principle incident to the prevention of these fires were not well understood, there is no doubt that the operation of the steam locomotive through forests and grass lands were the cause of fires in areas adjacent to the right-of-way. Incidentally, some of these fires were undoubtedly the result of improperly designed and inadequately maintained ash pans. Also in those days, most locomotives had no brick arches and had short flues and the unit combustion rates were much higher than in modern locomotive practice.

Extensive tests at Purdue University revealed that the standard front end netting was most effective in preventing the escape of cinders large enough to cause fires in adjacent areas to the right-of-way. However, in addition to the use and proper maintenance of front end netting, all plates and joints in the front end must be kept tight to prevent the short circuiting of cinders into the stack extension.

Under the supervision of the New York State Public Service Commission coal burning steam locomotives have been operated successfully in the Adirondack Forest Preserve under difficult grade and curve conditions without causing fires. Twenty-five locomotives inspected and certified by the above Commission Inspectors participated in this service.

As stated previously, some railroads still report difficulties of this nature, possibly because of the type of coal utilized. In the discussions, to follow

the reading of this paper, comments from the floor on this subject would be appreciated.

In the light of present day knowledge this problem should be capable of quick solution.

The second phase of fire prevention has to do with practices at locomotive terminals and shops.

Several fires have been caused by firing up locomotives when same are not properly placed under smoke jacks, and it should be the Boiler Maker's responsibility to see that locomotives are properly placed before the fires are ignited.

Numerous fires have resulted from carelessness in the use of oxy-acetylene welding and cutting equipment. The manufacturers have available detailed instructions regarding the storage and handling of acetylene and oxygen cylinders. The Master Boiler Maker must comply with these instructions. Also inflammable material must not be exposed to the heat flame and sparks from welding, heating and cutting torches. Carelessly operated welding equipment has also been a fruitful source of unnecessary fires. A single remedy is to keep inflammable material away from the heat and sparks created during the welding and cutting operation.

Most railroads have rules regarding the storage and handling of lubricants, paints, carbides and other resinous inflammable or potentially inflammable material. The Master Boiler Maker must know these rules and follow them.

MR. P. K. INGLE
District Inspector, Board Transport Commissioners, Canada

Perhaps, in those "Good Old Days" the question of the emission of black smoke from the stacks of steam locomotives, and the setting of fires along the right-of-way, was considered the normal results to be expected from coal burning locomotives.

To-day, we are still plagued with track-side fires and the emission of excessive amounts of black smoke. To-day, however, there are many reasons why the members of our Organization simply cannot afford to shrug their shoulders and say "So what": One of the most logical reasons — perhaps a selfish one — is that today we have in our midst the Diesel Electric Locomotive.

Those of our members who are presently concerned with the construction, or maintenance, of steam locomotive boilers and ashpans are, undoubtedly, well aware that in the construction, or maintenance, of diesel engines, the amount of work available for boiler making craft is limited.

As an organization, we are vitally interested in keeping the steam locomotive rolling, and in keeping to an absolute minimum the replacement of steam locomotives by diesel engines. Two effective ways of helping to achieve this is to make a determined and concerted effort to reduce to a minimum the harmful and appallingly costly results of track fires and excessive black smoke. To do this, all our members concerned with the design, construction or maintenance of locomotive boilers, ashpans or fire protection appliances, must work to this end; otherwise, who can blame Railway management if they consider the excessive emission of black smoke, and constantly recurring fires, along the right-of-way, as two more very logical reasons for turning to diesel power as an answer to these problems.

My duties, as a District Inspector with the Board of Transport Commission for Canada, includes, among other work, the inspection of fire

protection appliances on steam locomotives, and to see that the Fire Prevention Laws are properly observed by all railways operating under Federal Charter.

Perhaps you would be interested to hear how we approach the problem in our country? As you no doubt are aware, there are two major railway systems in Canada, the Canadian Pacific Railway, privately owned; and the Canadian National Railway, which is owned by the Canadian Government, but has an independent management. Both systems have transcontinental lines extending from the Atlantic Coast to the Pacific Coast. These railways have numerous branch and subsidiary lines. There are also a number of smaller privately owned roads and numerous small private industrial roads. As well, there are two Provincial Government Railways operated by the governments of Ontario and British Columbia. The approximate total mileage being 42,000 single track miles.

In transversing such a distance as these, our railways naturally pass through many towns and cities, large and small, and through vast tracts of valuable timber lands.

Needless to say, in a country so bountifully supplied with timber and forested lands, the products of which make up one of Canada's largest industries, it is a matter of first importance that these properties be protected from fires. Hence, the fire prevention laws, as applied to Canadian Railways, and to American railways operating in Canada, are very strict, and are rigidly enforced. It should be noted, in all fairness, that generally both railway management, and employees, are extremely "Fire" conscious.

Canadian Railways are now using the Master Mechanic type of front end, almost exclusively. After experimenting with a varied assortment of spark arresters, this type of front end is generally considered to be the most suitable and most efficient. It is generally used with a square mesh type of netting; same having 2⅔ by 2⅔ mesh to the inch; the strands being made of No. 10 B. W. G. Condeming limit of mesh opening being $\frac{13}{16}$", and wire strands are condemned when they thin to .065. The oblong type of netting with openings not more than $\frac{5}{16}$" in width and ¾" in length, made of warp N. 10, shute No. 9 B. W. G. is acceptable but not in general use.

With reference to ashpans used on Canadian locomotives; the design and construction, of course, vary considerably. While some are more efficient than others, and — acknowledging the fact that none are perfect — I must admit that, in my opinion, the pans have been greatly improved during recent years. This improvement in design has produced a much more efficient and fire-proof pan, easier to inspect and, for the most part, easier to maintain.

However, to those of our members whose work entails the designing, of fabrication of new pans, I would urge that more attention be paid to the production of fool-proof dumping gear, and more efficient protection for reach-rod openings at rear of pan. Drafting arrangements on ashpans, on Canadian locomotives, have also improved very considerably. There is still, however, much room for constructive work by those of our craft who are engaged in the very important job of maintenance in engine sheds and roundhouses.

In Canada, the Federal Laws require that pans and front ends be given a complete examination every seven (7) days, and ashpans a pre-trip inspection. It is my definite opinion that if a thorough inspection is made of all fire protection appliances at time boiler is washed, and all parts reasonably cool, any necessary repairs can be made at that time, and little or no trouble would be experienced with defective fire appliances between wash-outs.

I have often noticed that maintenance staffs will carefully examine dead plates, for openings, and netting for wear, and then proceed to overlook

spread netting strands, which method is about on par with the man who locks all the doors before leaving home, and forgets to close the windows.

One of the most prolific causes of track fires is the improperly closed ashpan door, slide or damper, and I would stress the fact that, in many instances, where open, or partly open, ashpan doors have been found to have been responsible for causing fires, subsequent investigation has disclosed the fact that pan door was tightly closed before engine was turned out of engine house. The trouble is more often due to carelesness, or ignorance, on the part of the ashpitmen at turn-around points, or engine crews who find it necessary to dump the pan enroute, and it is here that the necessity for an easy-opening, and tightly but easy closing pan door, is most readily demonstrated.

Before dealing with the question of black smoke, I would like to suggest to our Executive Committee that they consider the advisability of impressing the management of our different Railways with the necessity for the adoption of the following measures that would, in my opinion, be a valuable aid in prevention of many track-side fires, some of which are unjustly blamed on defective fire appliances on locomotives;

1. The screening of all windows in non-air-conditioned cars during the fire season. I regret to say we have many such cars still in service on Canadian Lines.

2. The application of a simple type spark arrester on top end of stove smoke stacks in use on tail end vans, work train and passenger train, dining cars, boarding cars, etc.

3. The strict enforcement of the Rule requiring passengers not to stand in coach vestibules.

4. An educational campaign among all whose duties require them to work on, or close to, right-of-way, which would stress the dangers of leaving burning grass or slash fires; careless handling of cigarettes, cigar butts, and the danger involved in smoking while riding on track-motor-cars, or velocipedes, etc., etc.

A little further on, I will outline my own idea of how, and where, members of our Association, and those associated with us in the Craft, can do their part in helping to eliminate the emission of black smoke.

Just now, if I may, I would like to outline how Canadian Railways are tackling this problem in a general way.

In the first place, it would be well to mention that, in Canada, our Railways still have in service a large number of hand-fired yard engines. It is true there are an ever increasing number of diesel yard engines in service, but they are still very much in minority. Also, at this time, all our freight and passenger engines are coal or oil-fired steam engines, with the exception of about six (6) main line Diesels presently being used experimentally.

In Canada, the elimination of black smoke has become a very live issue. In all the heavily populated areas and, even in the smaller centers, the general public appears to have become very "smoke" conscious.

In large cities, such as Montreal and Toronto, Citizens' Committees have been formed, and as a result of the pressure applied to Municipal Authorities, anti- smoke by-laws have been passed. It is true that, in theory, these by-laws apply to factories and industrial plants as well as to the railways, but to me it appears that the biggest and loudest complaints are always directed to the railways.

Naturally, more complaints come from congested and residential districts,

where roundhouses or engine sheds are located, and from cities and towns, where the railways pass through, or penetrate to the center of the city or town.

The management of Canadian Railways have attacked this serious problem with vigor, and from many angles; some of which I will outline as briefly as possible.

In a general way, the emission of black smoke from locomotives, while working, can be blamed on three things; poor drafting arrangements, poor quality of coal, and poor firing.

The emission of excessive black smoke from engines standing on incoming or outgoing tracks, and from smoke jacks of roundhouses, while engines are being fired up is, in many instances, due to lack of an educational policy for those concerned, lack of efficient equipment and lack of proper supervision.

In our larger, more modern roundhouses, when they are located in residential areas, the direct steaming method of preparing engines for the road is in operation. In others, where it is the practice to line grates with coal prior to steaming up, an auxiliary air line is inserted into the firebox and air blown in during the time black smoke is being produced. This air jet causes a turbulence, and also provides an abundance of air both of which help materially to bring about more thorough combustion before smoke and gases leave the firebox. Where oil is used to steam up before grates are lined, particular attention has been paid to the design of torches in use, defective torches are repaired at once with particular attention being paid to operating valves. The temperature of the oil, which is generally piped through the shops, is also watched to make sure that oil does not thicken, and that it reaches the torch in an even flow.

All steam yard engines, and many of the hand fired engines, have been equipped with an "overdoor steam jet" which is operated when a fire is being put in. The railways have also appointed their own smoke inspectors; usually these men are experienced firemen, or classed engineers, and their duties are to watch both engines that are working, and those in and around roundhouses for evidence of excessive smoke. They contact the offender responsible; a warning is given plus some good advice on what caused the black smoke, and how to prevent it in future. Second offenders are more harshly dealt with. Over and above these efforts, strong educational campaigns have been instituted for the benefit of all whose duties require them to operate coal or oil fired boilers, whether they are locomotive firemen, hostlers, stationary firemen or firebuilders. These lectures and talks are illustrated by lantern slides and have been made rather attractive to the employees concerned who are always encouraged to ask as many questions as they find necessary.

The quality of coal has also been greatly improved in the past twelve (12) months. It is hoped that this improvement will be permanent.

With the adoption of the wider and square type ashpan copings, vertical deflecting fins and larger and more conveniently located clean out doors, drafting arrangements on the larger of our locomotives has also been improved very considerably which has not only assisted in reducing black smoke but has reduced stack losses with a reported saving of fuel.

Taking for granted that while the design of the pans and drafting arrangements on our locomotives are not perfect, they are about as good as there is, it remains for our members of the association, and their associates, whose duties are concerned with maintenance, to carry on the fight. No doubt the following advice is "Old Stuff" but it bears repeating.

It is necessary to check the height of smoke box diaphragm plate, and make sure petticoat and extension are secure and correctly lined up with the exhaust; also be sure that smoke box is airtight. Flues must be kept thoroughly and regularly cleaned, openings in grates free from obstruction to allow for free passage of air. Brick arches must be kept to the proper height and in good repair with upper surface cleaned off over flue area. The question of which is better, a closed arch, or one using end bricks, is debatable, but, in my opinion, more complete combustion will be obtained with the closed arch. Worn or defective stoker distributing plates should be repaired or renewed and last, but not least, keep ashpan air vents free from obstruction.

As you are aware, the foregoing refers to maintenance, or running work, but more often than not, the importance of seeing that these measures are carried out conscientiously and consistently, is sidestepped in rush hours, or when supervision is not all it should be. The logical result of slack maintenance is incomplete combustion, this generally is one sure reason for excessive emission of black smoke.

MR. FRANK D. HEIGLEY
District Inspector, Interstate Commerce Commission

The problem of smoke abatement is one that has been with us in this country for over 100 years and in parts of Europe for 200 years. It has been attacked from the point of its devastating effect on the cleanliness of our cities and more recently from the point of its serious effect on our health. Dr. Charles S. Cameron, Medical and Scientific Director of the American Cancer Society has listed smoke pollution as one of the major factors that favor development of cancer in humans. Dr. Clarence C. Mills, Professor of Experimental Medicine at the University of Cincinnati, one of the nations top authorities of the effect of smoke on the human body has made a comparison of the amount of smoke pollution and public health records in a half dozen cities in the United States with the result that the more smoke pollution there is, the higher the death rate from cancer of the lungs, tuberculosis and pneumonia. In Chicago alone, there are 700 unnecessary deaths a year to these three diseases, deaths that might have been prevented with less air pollution.

Respiratory diseases, from the common cold to the more serious ones are responsible for 70% of all lost time from work. Without the constant irritation of a smoke polluted atmosphere, we would all be much less susceptible to these illnesses. So much for the seriousness of the smoke pollution on the general health of the country.

It has been estimated that 20% of all fuel used in the United States never produced heat but is wasted in the form of smoke. From this figure it can be seen that the wasted fuel in the form of smoke approximates $150,000,000 a year. A large portion of this waste is by the railroads of this country. This tremendous waste when it is absorbed by the various railroads means the difference between operating in the red and black on several railroads. To make up the loss from this wasted fuel, it has been necessary to make other economies which has hit the employees of the railroads in the form of lost jobs.

In 1915 an investigation in Chicago showed that locomotives were responsible for 22% of all smoke pollution in the city. Due to electrification of railroads and thru co-operation between railroad managements and civic interests by 1941 the railroads were responsible for approximately 10% of smoke pollution. Due to the expanded use of diesels since 1941, the railroads responsibility for smoke pollution has undoubtedly been further reduced by 5% so that as of today, the railroads are not responsible for more

than 5% of the total smoke pollution, yet they are the chief targets of criticism regarding smoke pollution.

The problem of smoke abatement in so far as the Master Boilermakers Association is concerned is predicated on the following six (6) points:

1. Proper design and maintenance of the front end for maximum combustion efficiency.

2. Proper design and maintenance of ash pan and fire grates for admission of the necessary amount of air for complete combustion.

3. The proper size and location of the arch.

4. Properly designed valve gear to give maximum output with the lowest back pressure in the cylinders.

5. Proper over fire jets to create turbulence in the firebox thereby improving combustion and reducing carry over of cinders.

6. Clean flues to give free movement to the escaping gases of combustion, in order that proper combustion can take place in the firebox.

Another item very closely related to the subject of this paper, although entirely out of the hands of the Boilermaker, is the type and quality of fuel used. As an example, I cite two railroads with which I am very familiar and which approximately parallel each other. Both railroads used heavy Mikado locomotives of approximately the same specifications. Railroad #1 operated for the period of 1942-1948 without a single steam failure and only cleaned flues at the monthly inspection. This railroad had no coal mines on it and therefore were free to purchase coal where the best could be obtained. Their coal specifications called for a high B.T.U. screened coal minimum 2 inch lump which cost the railroad an average of 56 cents a ton more than run of the mine. Railroad #2 for the period of 1942-1948 averaged 10 to 15% steam failures and were required to clean flues an average of three times between monthly inspections and used an average of 20% more coal per gross ton mile than railroad #1. Railroad #2 was using a very inferior grade of run of mine coal and were constantly being cited by the local authorities for smoke violations.

Smoke has been defined by Webster as "Small particles of carbon given off in the process of combustion." These small particles of carbon or smoke as it is termed, are all combustible particles and should have been transformed into heat and colorless carbon dioxide before being exhaused to the atmosphere and represents the 20% fuel loss mentioned earlier in this paper.

In order to burn a fuel completely, it is necessary to keep it hot, give it sufficient air and sufficient room in which to burn. The problem of keeping it hot and giving it sufficient room in which to burn are problems over which the boilermaker has control in the design of the boiler with proper design of draft appliances, firebox and combustion chamber size, and grates to admit sufficient air for proper combustion. Additional amounts of air can be admitted to the firebox thru the installation of steam air over fire jets. In addition to admitting more air, these jets create turbulence of the gases of combustion in the firebox more readily bringing the hydrocarbon particles into contact with the oxygen of the admitted air and transforming them into heat and CO_2 thereby eliminating the expulsion of the carbon particles out of the stack in the form of smoke.

In the induction of air into the firebox thru the use of steam air jets it is fundamentally essential that the air be admitted as close to the fire bed as possible, in order that the air may be present at the point of distillation and thereby be accessible to the hydrocarbon molecule at the time it is evolved, otherwise, the heat will break up the hydrocarbon molecules and the

liberated carbon will form with the other carbon particles too large to be consumed in the short period of time available before being exhausted out the stack in the form of smoke.

Proper temperature is also very important since in addition to combustion therewith, a chemical reaction is taking place in the firebox. Chemical reaction is much greater and the combination of the oxygen with the hydrocarbons in the process of combustion is much quicker at higher temperatures than at lower temperatures.

Summarizing, The Master Boilermakers Association's responsibility in the field of smoke abatement evolves around the problem of proper design of the locomotive boiler with sufficient boiler and firebox capacity for complete combustion along with the installation of proper over fire steam air jets to create turbulence in the firebox and in the proper maintenance to keep the component parts of the boiler in condition for maximum efficiency. In addition to this, The Master Boilermakers Association can by working together with the Railway Fuel Supervisors' Association work toward the goal of obtaining the best possible fuel for use on the locomotives. If this is not done and the smoke nuisance abated, the boilermaker will be the one to lose out if the diesel entirely supplants the steam locomotive. The future of your job hinges at this time to a great extent on whether or not the smoke nuisance of the steam locomotive can be abated. It is up to you.

As to the second part of this topic, "What Can the Master Boilermakers Association Do Toward Fire Prevention," I am of the opinion that the railroads responsibility for causing fires has been grossly overstated. The largest fires that have plagued this country have originated miles from any railroad, yet if a fire does originate within a mile of any railroad, the assumption is that it started from a spark from a locomotive. More fires are caused by carelessly tossed cigarettes from passing autos than from sparks from a locomotive.

In the front end arrangement of modern locomotives, every precaution has been taken to prevent the expulsion of fire producing sparks and is producing results when they are properly maintained. Ash pans are so designed to prevent the dropping of hot coals which would tend to start fires and if they are properly maintained, no fires will be encountered from this source. The primary cause of fires which are started from exhausted hot cinders, is the inferior grade of coal being used and the high degree of fine coal which permits the fine particles of fuel to be ignited in suspension in the firebox and then exhausted out of the stack to the atmosphere never having come in contact with the fire bed. This again is out of the hands of the boilermaker and is the responsibility of the Railway Fuel Supervisors Association.

If the front end is properly designed and maintained, the boiler and firebox maintained, the ash pan and grates properly designed and maintained and the proper fuel provided so that the locomotive steams freely, the tendency to overcrowd the fire will not be present and it can be kept in condition for maximum efficiency, thereby eliminating the necessity for frequent stops for fire cleaning and the dumping of ash pans in places where ensuing fires can start. This speeding up of the trains hauled by steam locomotives places the steam locomotive in a better competitive position with the diesel and preserves jobs for boilermakers.

In conclusion, the problem of "What Can the Master Boilermakers Association Do to Aid in Smoke Abatement and Fire Prevention" is one of maintenance. The modern steam locomotive of today is an efficient power plant and if properly maintained, can be operated without making objectionable smoke and without danger of creating fires. In addition to proper maintenance, it is fundamentally essential for the Master Boilermakers Association to work in close harmony with the Railway Fuel Supervisors

Association toward the goal of obtaining the best possible fuel for the steam locomotive in order to work toward the ultimate goal of complete Smoke Abatement and Fire Prevention.

MR. S. A. FEGAN
District Boiler Inspector, Canadian National Ry.

I realize that all responsible executives and mechanical members of a railroad have been exerting their efforts over many years to improve the drafting areas and design of the locomotive, to effect the greatest efficiency at the lowest fuel cost. The results, in my opinion, have brought about an almost general standardization over the American and Canadian Railways and the difference in opinion is governed principally by the quality and B.T.U. value of the fuel used. Due to the difference in fuel quality, one road apparently carries on favorably with the old and fundamental design while others seek improvements to gain a more economical and satisfactory situation.

It is with the above in mind that I express my opinion and compile certain data which covers my experience in the past and at this time presents a condition over the territory I cover on the Central Region of the Canadian National Railways, that compare favorably and excel many roads in the minimum consumption of fuel and consequent smoke abatement as confined to the conventional and restricted areas of the coal burning locomotive of today. If we could only free ourselves of this limitation, there would be a vast field for a new design and encouragement for us Master Boiler Makers.

In support and relation to the above, I will quote the data governing the fundamental air and gas areas of our freight and general service engines of a class and major importance in heavy transportation, areas for other power corresponding to class. These standards have been arrived at to meet the average quality of fuel which has a value of approximately 1,300 B.T.U.; 30 to 33% volatile and 9% ash. There are periods experienced when an inferior grade to this is used and it is quite obvious that areas are not entirely suitable especially in regard to air admission.

In further support of the data given, observation of smoke emittance of engines in general service has proven that with engine and boiler in good condition, they can be operated without any special eliminating devices within the smoke ordinance order and the #2 grade or 40% dense smoke rating.

Herewith the basic data of the class of locomotive selected, which is the Northern Type of 57% rating; boiler carrying 250 pounds working pressure.

% of ashpan opening to grate area	13%
Grate area	84.3 square feet
% of grate air opening	Holes 13.92%, overall 19.4%
Style of grates	Round holes ⅝" dia.
Grates level or inclined	Inclined 15" in 137"
% opening top of sealed arch to tube gas area	108%
Number of syphons and arch tubes	2—3
Length of combustion chamber	48 - ½"
No. flues and tubes; 21' 6" long	145 - 4"; 33 - 2¼"
Area of flues and tubes	1267 square inches
Type of front end	Master Mechanic
Distance from front tube sheet to baffle plate	27 inches
Area under table plate	23½" — 119% of tube area
Area under diaphragm plate	18½" — 69% of tube area
Size of nozzle tip	8⅛"
Size and type of bridge	½" cross bar

Distance from tip to base of stack extension	18⅝"
Diameter of base of stack extension	32 inches
Size of stack	20 inches
Overall length of stack and extension	56⅛ inches
Boiler feed (top check with T nozzle)	1 Elesco H-40 F. W. heater 1 Elesco C.F.1 pump 1 Injector
Superheater	Schmidt — type E
Smoke consumers	None

The above data is intended as an example and reference to my opinion expressed and not as a recommendation, as I realize from subjects over the past thirty years on and relating to design that there will be a varied difference in opinion. Personally, I am a firm believer in testing out the old time theory and fundamental principals thoroughly and if these do not meet approval under existing conditions and circumstances, then pass on to devices and alterations that will realize an improvement.

From past discussions and contact with others dealing with this subject there remains, in my opinion, much attention and study in many cases to the basic items such as type of grates and percentage of air opening and the other relative percentages of areas from firebox to front end as against the total tube area. The sealed arch, in my opinion, is most important and I believe is detracted from in many cases to assist in overcoming the destructive agent of cinder cutting. The front end areas from area under diaphragm to seal point in stack. The increasing of circulation in firebox legs by means of adding syphons and circulator tubes. The position of boiler check has proven most important over my experience, the application of the top check with a short T or spray nozzle being a vast improvement in both water temperature fluctuation and firebox repairs, over the old side check. The location of steam dome and its value as compared with the perforated steam pipe and outside header, are important studies. Such items as these have direct bearing on the subject and are a part of the boiler in its simplified construction. From here we can deal with the different and numerous appurtenances both locally made and manufactured that may warrant an overall expenditure in an effort to obtain the greatest value from a pound of fuel.

With the boiler and front end considered efficient, we naturally look for and expect reasonable smoke elimination. This is also part of the subject that extends back over many years when the air tube was placed in the side sheets followed by the inserting of a steam jet which was then considered by some managements as a drastic waste of steam and money. Time has led us to the demands of today and the various attachments to curtail smoke. Of these, the modified overfire air jet with silencer, with the steam nozzle forcing a percentage of air over the fuel bed, is the most reasonable and effective and possibly one of the most expensive. On this territory they are used quite extensively on yard power only. Tests have proven that they are very efficient under reasonable firing and will reduce smoke from the dense state to the opaque in 50 seconds or less. They are applied in the customary number and location, three on each side staggered in a line about 14" above grates, with exception of the back one which is in line with the bottom of the firebox door. With this appliance being difficult to locate in cab and around attachments, etc. on outside of firebox, also expensive, it was recently decided to try out the old and original T pipe steam jet which no doubt is well known to all. The jet is made of a piece of heavy ½" to ¾" pipe, 5 to 8 inches long, or a material more heat resisting. There are eight 3/32 to ⅛" holes spaced in the tube from 90° center to 30° at end in accordance with the spread required. A plug is placed in one or both ends for cleaning purposes. This jet is attached to a ½" steam pipe, generally passing through the top of the fire door frame and rests at top of door flange of required

distance from back head to protect it from unnecessary heat and permit a spread as close to the back head as possible.

It is recognized this type of appliance is not durable due to heat and carbon, yet, it is inexpensive and may be easily renewed and is satisfactory in meeting the approval of both Company and Government officials. This device is now being applied to certain road engines as a convenience in clearing smoke when engine is standing, etc. and also generally applied to stationary and work equipment boilers.

I recognize that there are many devices and chemicals on the market that no doubt prove of value if necessity demands, also designs as made up by the different companies. Most any type of a consumer will assist in smoke elimination, therefore, it is imperative that the most economical device be applied that will meet local requirements.

The final part of this subject "Fire Prevention" is also one that deals in a large degree with local circumstances, mainly the quality of fuel used and secondly, the proper drafting and in some cases, the required baffling to prevent unburned fuel from being emitted from the stack. There was an occasion last year during a hot and dry period when the use of one car of light grade coal with an apparent tar-like content was the result of more fires than would ordinarily be experienced in years. I quote this to demonstrate that the necessity of having to use such a fuel would entirely change our present standards. A part from the drafting of locomotives on this region as given in data, the Draftac style of front end netting with mesh opening ⅛" by ¼" has become most popular due to more free admission, less plugging and greater wear.

This subject brings into effect the regulations and limitations as laid down by the Federal and State Railway Commissioners and if we meet and maintain such conditions, perfection in design will find a way to meet a serviceable construction.

I consider that personal responsibility plays a great part in maintaining good front end and ash pan conditions. On this road the system has been set up of having the Inspector affix his personal signature to all inspections made. This does not only apply to the official seven-day inspection but also the form in cab of engine and the work reports covering engine on daily run. Intermediate inspections are handled in the same manner. This method, in my opinion, sets up a personal interest and responsibility that prove beneficial. I also believe in the old practice of the inspector using an oil swab in preference to the modern flash light.

In conclusion, I wish to state that I have tried to present practical details as designed and experienced in my position in the form of a review. Apart from the locomotive design, approved by the Company, I have refrained from being explicit in regard to details of the different appliances, etc. A part from the subject and relative to any effort on the part of science and skill of the Master Boiler Makers and their associates, all efforts and credit are nil unless the operator taking over does his dutv. Much criticism and reflection is directed to the Mechanical Department that in my opinion rests with those in charge and responsible after the product is turned out.

MR. J. J. DESMOND
Round House Foreman, Washington Terminal Company

"Smoke Abatement and Fire Prevention" have been the source of much study and consideration due to the interest of the "General Public and Municipal Authorities" in the subject of "Air Pollution."

Manufacturing plants, such as steel and chemical plants, railroads, and many other industries, who have their own power plants and generate their

own power, have had to give deep consideration to the subject of "Smoke Elimination and to the Soot and Fumes which are carried by smoke." The Smoke Prevention Association of America have, also, given careful consideration to this subject and the records of their conventions have been published in book form and I presume, that should one desire to obtain copies of these, that they may be had for the asking.

The Committees of this Association are composed of Professors, Engineers and other talented men who are proficient from both a study and practical stand-point in the subject of the elimination of smoke, soot, fly-ash and gases. Their research, which has been extensive in the laboratory and in the field, should be of great help in eliminating, to a large degree, the "Smoke Nuisance" with which our large cities have been and are still being polluted. This Association is still seeking and spending large sums of money in experiments trying to devise some method which will completely eliminate smoke, soot and gas from the air we breathe.

Railroading, which is the phase of this subject in which I am most interested, has various methods for eliminating "Smoke." Each railroad has its own method which it thinks works best on the types of locomotives which they use. Some railroads use the over-fire steam jet, others use a smoke eliminating device on the side sheets of the firebox and still others use a steam jet ring around the top edge of the smoke stack. All of these methods, while they do not eliminate smoke, are very helpful in cutting down the amount and density of the smoke made.

The City of Washington, in the District of Columbia, the place I am most familiar with, has a very strict law with regard to smoke. The District Inspectors, whose responsibility is to see that this smoke law is obeyed make frequent visits and checks for smoke violation. These Inspectors will allow smoke of a number 3 density by the Ringelmann Chart to be emitted for a period of one minute before they will give a violation. I might add, that the smoke violations given to the railroads in the City of Washington, have been very few and we have been commended by railroad men and by Inspectors from coast to coast on the results accomplished by our effort to prevent smoke in the Nation's Capitol.

The Washington Terminal Company and all the railroads which operate in and out of Washington, have formed a Smoke Committee which meets once a month in the Manager's Office of the Washington Terminal Company which is in the Union Station, and talk over smoke conditions. There are five railroads and The Washington Terminal Company represented on this Committee. During the meetings if any violations have been received they are discussed and ways of preventing such a violation again are discussed.

All the Foremen and Gang Foremen, inside and outside hostlers, fire knockers and fire builders, and any extra men who might fill any of these positions on The Washington Terminal are educated to a point where, if they see any smoke being emitted from a smoke stack or even see a slight discoloration, they immediately go to that engine, find out the cause for the smoke or the discoloration and then correct it.

The educational system which we use on The Washington Terminal consists of three phases. First; these men are taught the proper ways of building and maintaining a fire. Second; notices are placed on all bulletin boards from time to time which calls to the attention of every man working in the shops, the fact that it is his responsibility to help in eliminating smoke and fly-ash. Third; we have three special duty engineers, each working an eight hour shift, on duty during the twenty-four hour period each day. These men give their undivided attention to the elimination of smoke. They watch for smoke in the engine house territory and when they

observe it being made, if some individual is responsible for the smoke, will instruct them in the proper way to do what they are doing without making smoke, and if no individual is responsible for the smoke they proceed to stop the smoking.

I devised a portable smoke consumer in 1945, which was adopted by the Washington Terminal Company, and the office of the Chief Engineer had blueprints made of this on July 3, 1946. I would like to submit a copy of this blueprint for you gentlemen to observe. This idea is not patented and any railroad can use it without cost other than the cost of making it.

We use this portable smoke consumer on every engine when we are building the fire and we have found that it will eliminate the smoke and will cause about 95% of the gases to be reburned. We build our fires by first placing a layer of low-volatile coal in the firebox approximately four inches deep, having it slightly higher on both sides and at the door sheet, and then with a portable oil fire-lighter, we light the fire. The portable smoke consumer is kept on during the entire process of building a fire. We have these smoke consumers placed between every other track for the convenience of the employes, so that they can be used on all the locomotives that come into the round house with the fires burning, so that the fires can be built up without making smoke. We, also, have these placed on the fire track and as soon as an air line is run to the ready track these smoke consumers will be placed at that point, so that the engine crews may use them when they are preparing their fires. In fact there is one railroad that has these smoke consumers placed all over its yards, fire track, and engine house. When properly used, as shown on the print, you can rest assured that your smoke troubles will be over.

One must always bear in mind that to eliminate smoke every man, who is in a Supervisory capacity must be definitely smoke-minded and that an Educational Program on "Smoke Abatement" must be set up before much progress can be made in the elimination of smoke.

Considering again this portable smoke consumer. The question was asked if steam would be as effective as air in eliminating smoke. I, therefore, placed a two inch thimble over the fire door of one of our yard engines and placed the clam shell mouth on the end of a ¾" pipe nipple and had it just about in line to hit the fire, as shown on the blue print. The steam, while it did a very good job of eliminating smoke it was not as good as air because air makes the best turbulents in burning gases. I, also, believe that these smoke consumers might be used on the road, if two of these were placed in the back head of each side of the fire door hole and if an auxiliary air reservoir was placed on the engine for this purpose, that about 80% of the smoke would be cleared up on the line of road and it would be entirely eliminated at stations.

Mr. M. G. Stewart, the Road Foreman of engines for the Washington Terminal Company, demonstrated this portable smoke consumer at the Annual Convention of the Smoke Prevention Association of America held at Minneapolis, Minnesota, in 1946. A large passenger locomotive belonging to the Soo Railroad was used for this demonstration. Using a small firebox, the fire was broken up and when a better than number 5 black smoke was being emitted from the stack, the portable smoke consumer was turned on and there was a clear stack in from two to three seconds. Then someone suggested that it be placed in a large firebox to see if it would have the same effect there. This was done and the same results were observed in the same length of time. From this you can see that we receive a great deal

of satisfaction in as much as our study and efforts have produced such splendid results.

However, this is a large field, and maybe some one can pick up my idea and carry it further. This method of eliminating smoke is very economical and the manufacturing cost is very small, I believe that if some large railroad will give this idea consideration, as I know it will eventually, that this smoke consumer would lead to the desired results in eliminating the smoke nuisance.

I would like now to direct your attention to the subjects of fire prevention from the railroad standpoint. Fires along the railroad right of way, on the road beds, bridges, and other places have been an expensive proposition to the American railroads. This condition has been brought about by many factors. The bad conditions of the ash pans and front end arrangements, such as holes in nettings, openings in baffle plates, angle irons not fitting properly to the contour of the smoke box, holes in ash pans, sheet irons being deteriorated at the ash pan casting, lost motion in rigging and doors not being properly closed are a few of the things which have caused this condition. When these conditions exist on an engine it shows that they were very poorly and loosely inspected. With proper supervision and inspections these conditions would not exist and therefore, fires which are caused by these conditions would be eliminated.

It has been found that the majority of this trouble comes when the Master Mechanic front ends are used. There seems to be less trouble experienced when the Cyclone front end of the Thompson front end with the venetian blinds is used. These last two front ends have a tendency to break up all the sparks so fine that they are out before they strike the ground or any object which would cause a fire. However, I believe, that these bad conditions are caused mainly by gross negligence in maintaining these locomotives. With proper maintenance the causes for fires along the railroads would be eliminated.

I have tried, gentlemen, in presenting this paper, to show you how you as Master Boiler Makers can aid in Smoke Abatement and Fire Prevention. I trust that I have given you some ideas which will be helpful and usable in the various industries in which you are employed. If I have done this I have succeeded in my purpose.

MR. J. D. JOHNSON
Chief Boiler Inspector, Missouri Pacific Lines

Over a long number of years our railroads have concentrated on programs of smoke abatement and fire prevention, but believe that much more can still be done to reduce losses from black smoke and fire damage. By proper inspection and maintenance of locomotive fire appliances boilermakers can do much to protect our lines against undue, and in a great many cases, unjust fire damage claims.

The boilermaker is not confronted with the job of designing locomotive draft or fire appliances in our coal burning engines. This is being handled by Mechanical Engineers who are authorities on the subject. Men have spent their lives conducting tests of various front end spark devices and draft appliances, especially at the Universities of Purdue and Illinois; and have come to the conclusion that if front end spark arrestors, ash pan and so forth are inspected regularly and maintained in first class condition by boilermakers there can be little danger of fires being set along the right of way to cause damage to our own or other privately owned property.

The boilermaker can play a very important part in black smoke abatement by sticking to sound principles of good inspection and proper maintenance of front ends, smoke boxes, draft appliances, spark devices, brick arches, grates, ashpans, flues and fireboxes. To make myself more specific I will go into a little detail.

1. Front end smoke boxes are real important in relation to the combustion of coal gases. Clean front ends maintained in an air tight condition create a perfect vacuum. This eliminates the danger of fine particles of fly ash passing afire through flues into the smoke box shooting out through the smoke stack to create a fire hazard.

2. Locomotive front end spark and draft appliances should be inspected after each day or trip and all defective conditions repaired. If front ends are properly maintained there is little danger of setting fires. Nozzle stands, lift pipes, extensions and smoke stacks should be correctly aligned. Patches or obstructions should not be applied and permitted to interfere with the smooth flow of a full stack. A full smoke stack without air pockets is necessary to get a good combustion of firebox gases. If good combustion is achieved flues stay open, a large amount of fly ash is consumed, fuel is saved, and black smoke is kept to a minimum.

3. Firebox brick arches are extremely important. They provide an oven or mixing chamber for the coal gases and air that have passed through the grates and fire bed. Between the brick arch and grates the air and coal gases are mixed at a very high temperature causing a longer flame travel so necessary for good combustion of firebox gases that eliminate black smoke.

4. Due to the limited amount of space that can be allowed for them, grates must consume coal from one hundred to one hundred and fifty pounds per hour per square foot of grate surface. From this and the amount of train tonnage it can be readily seen that air openings in grates must be kept in first class conditions if we are to get complete combustion of coal gases in fireboxes, clean fires, clean fireboxes and clean flues. In addition to a good air flow design grates should be given proper inspection and maintenance service. Grate bars must be set up tight to the sides of the fire box and mud ring. If they are loose, air, passing between side bars and the side of firebox sheets, forms a blanket of cool air between the firebox sheets and the fire. This causes a total waste, very injurious to side sheets and staybolts, starts seep leakage and vertical cracking out of staybolt holes, and is of no benefit to the combustion of firebox gases.

5: Another real part of the locomotive combustion system so important in the elimination of black smoke and the prevention of fires are ashpans. Doors, hoppers and slope sheets must be kept in first class condition so as to be air tight, then all unburned coal, slag, and other coal wastes that fall through the grates into the ash pan will be smothered, thus eliminating the possibility of burned bridges and other property along the right of way. Ill functioning ash pans are not only a fire hazard, but a safety hazard to employees and the general public. Air for a firebox combustion must pass through grates and fire bed, and proper air opening at the ash pan wings must be maintained.

The Boilermaker has no control over some of the conditions that effect smoke abatement and fire prevention. Some of these are; the improper firing of locomotives with fire doors open, the wrong and unnecessary use of blowers to clear smoke stack, and the blowing of coal particles over the fire into the flues. There are others, too numerous to mention.

Here I wish to use a quotation from Smoke Prevention of America, Inc. "Smoke has no defense." It wastes millions of tons of fuel, poisons the air, destroys property, spreads disease and discomfort. In the May issue of Readers' Digest the following statement was written, "Smoke may become an imminent peril to life and health as proved in October, 1948

when within 48 hours a blanket of smoke fog killed 20 people, sent 20 others to the hospital and left 400 with respiratory ailments. Other communities may suffer the fate of Donara, Pa. It is interesting to note that when the U. S. Health Service Bureau made a survey in 1932 and 1933 to find out which American City had the worst air pollution the startling discovery was made that the four most polluted cities were Pittsburgh, Boston, Baltimore and St. Louis. Death rates from pneumonia, tuberculosis and lung cancer are three to five times higher for people in the dirty districts than in the cleaner suburbs."

In conclusion I wish to say that I believe the boilermaker should stick to the things with which he is most familiar. They are of extreme importance in the elimination of black smoke, fly ash and fire hazards. It has been my observation that present day smoke consuming devices, while they are partly successful, leave much room for improvement in smoke abatement. Nearly all of these devices are over fire jets of steam and air. As a result they can only have a washing action on the firebox gases, and do not aid the complete combustion of gases after they enter flues on the way to the smoke stack, and we can only say that in order to increase the efficiency of smoke consuming devices, a method must be arrived at to consume more of the firebox gases in the firebox.

MR. DENNIS P. VERNON
Boiler Foreman, Reading Railroad Company

In the abatement of smoke, proper maintenance of steaming facilities and drafting facilities are the main factors insofar as the Maintenance of Equipment is concerned. Any deviation from standard dimensions, or any conditions which will increase consumption of fuel, or interfere with the free drafting of the locomotive will definitely result in increasing amounts of black smoke being emitted from the stack.

In the maintenance of steaming and drafting facilities, the following have an important bearing on smoke abatement:

BRICK ARCHES: In a locomotive equipped with brick arches, the gases, instead of passing directly through the flues, are first deflected by the arch and again pass over the fire bed. This naturally increases the consumption of any unburned gases or particles of fuel before the smoke finally passes through the smoke stack.

Therefore, it is important to maintain brick arches in good condition at all times, for if any portion of the arch is broken down or missing, these gases will naturally flow through the openings thus made, and will pass out through the smoke stack with an increased amount of unconsumed fuel and gases and increase the density of the black smoke being emitted.

FLUES: Clean flues are a necessity, and it is imperative that a program of regular cleanout periods be set up and followed religiously. Flues coated over or stopped up will naturally affect the drafting qualities of the locomotive.

Likewise, leaking flues, superheater units or header, or steam pipes in front end will seriously affect the drafting of the locomotive. Such leaks will cause flue sheets to be coated over and block the flues. This will in turn cause uneven draft in firebox and result in a more rapid combustion of fuel on the side on which draft is free, and poor consumption on the opposite side.

FRONT END EQUIPMENT: The size of exhaust nozzle is very important in regards to combustion of fuel. The sizes are generally set up by the Engineering Department, and the nozzles must be maintained in good condition and free of carbon, for the original size has been set up

for the most economical consumption of fuel, while maintaining the desired steam pressure, in the service for which the locomotive has been built.

It is important that lift pipe be kept at the proper height above the exhaust nozzle, the height having been set up for the type front end with which the locomotive is equipped. Lift pipe must be maintained in good condition, free of any unnecessary openings which would interfere with the proper consumption of fuel in firebox and cause engine to make excessive smoke.

Smokebox must be kept free of all air leaks which would destroy the vacuum set up by the exhaust and result in excessive black smoke.

Grates must be maintained in good condition in order that air can enter and pass through the fire bed. Any unnecessary openings in grates, grates cocked, etc., will result in an uneven consumption of fuel.

In this connection, ash pans must not be filled to the extent that the ashes are against the grates, as this condition defnitely will destroy the proper drafting necessary to perfect combustion.

Stoker blower jets must likewise be properly maintained at all times, for if fuel is not properly distributed in the firebox, an accumulation of unconsumed fuel will result, and this will naturally increase the amount of smoke passing through the stack.

As stated above, any condition which will increase fuel consumption will adversely affect the abatement of smoke. In this connection, scale on water side of firebox sheets is an important factor as it causes considerable loss of heat. The following table is based on determinations made at the University of Illinois, and shows the approximate heat losses that may result if scale is allowed to accumulate to the various thicknesses shown:

Thickness of scale	*Loss of heat*
1/30"	5.2%
1/32"	8.3%
1/25"	9.9%
1/20"	11.2%
1/16"	12.6%
1/11"	14.3%
1/8"	16.0%

Therefore the use of water treating chemicals is a factor in smoke abatement, since the accumulation of scale causes a loss of heat, which in turn results in increased consumption of fuel.

The blower also must be maintained in good condition, since it has a bearing on the consumption of fuel while a locomotive is in operation, particularly when drifting, as any rapid cooling of fire results in clinkers being formed, which in turn prevents air from passing through fire bed. By use of blower, formation of clinkers can be avoided and free drafting is provided.

Inspection of smoke box, spark arrestors and ash pans is very important.

Close daily inspections must be made of the spark arrestors in order that no sparks will be emitted that will cause fire along right-of-way which may cause property damage.

Ash pans must be maintained in a safe and suitable condition that fire and hot ashes will not fall along the right-of-way.

The Foreman in charge should make a close inspection at boiler wash period to see that all repairs required are properly made.

MR. G. T. SINGLETON
General Boiler Foreman, Erie Railroad

Black smoke has been discussed on the railroads for a number of years. In most of the cities along the railroads they have smoke ordinances prohibiting black smoke within the city limits. These smoke ordinances started to be put into effect as far back as 1912 and every year more cities have adopted smoke ordinances until, at the present time, about all of the cities in this country have smoke ordinances and employ smoke inspectors to check on black smoke. We still have black smoke.

I have read many articles in magazines on the subject of black smoke, its causes and how to prevent it, also articles on smoke abatement from the Smoke Prevention Association of America. We still have black smoke.

On the railroads we have gone from the old style smoke consumer tube to the present steam operated over fire air jet, which forces air over the entire surface of the fuel bed. We have applied shields in the sides of the ash pans to distribute the air more evenly under the grate area. While these devices have helped, we still have black smoke.

There are quite a number of jobs that must be done properly in an engine so that it will burn its fire properly and they all enter into smoke abatement.

The entire interior of the firebox must be kept free from leaks. On engines equipped with superheater units, they must be kept tight and free from leaks either in the unit itself or at the joint of the header. Ash pans must be properly applied and the required air space between the mud ring and ash pan maintained so that as much air as possible is admitted under the grates, grates have to be properly cleaned so that there are no restrictions at any of the air openings in the grates and at the same time the opening between side frames and dead grates, if they are used, and the firebox sheets kept as tight as possible, so that as much air as possible will go up through the fire. Flues must be kept open and clean their entire length as well as just the honey comb that forms on the back flue sheet around the beads on the flues so that all the flues take care of the gases from the fire-box. Particular attention being given to the small flues as it is the small flues that plug up and honey comb over a good deal faster than flues of a larger size. The front end arrangement has to be kept in good condition so there are no obstructions to the stack. Exhaust pots to be maintained free from leaks at the joint and tips and nozzles maintained in good condition. Smoke boxes and smoke box fronts should be tight so that there are no air leaks to interfere with the draft of the engine.

Applying the over fired air jets and applying and maintaining the above mentioned items comes under the mechanical department. The boiler maker can do a lot of good in smoke abatement by seeing that all of the items under their jurisdiction are properly applied and maintained.

Until such time as a better way is found to force air over or through the fire in the correct proportion to the amount of coal that is put into the fire box so that all gases and fine particles of coal are burnt up before going through the flues and out of the stack, we will continue to have black smoke.

On the question of fire prevention with the present type of ash pan and front end arrangement, if properly applied, inspected and maintained, there should be no fires along the right of way.

Mr. Gilley (continuing): Our very good Secretary has suggested that I devote only about twenty minutes to the reading of this Topic. I would have liked to have read all of these papers, and I do hope that each of you gentlemen in your spare time have gone through these papers and thoroughly digested them because the members of this committee in the papers submitted to you have given valuable information which I am sure can be utilized by each of you to its fullest extent.

The subject of smoke abatement and fire prevention is a matter of maintenance of the equipment in so far as the Master Boiler Maker is concerned, and I am sure that each of you here today has some method of maintenance that will be of benefit to all of us in the abatement of smoke and prevention of fires. In the discussion period of this topic, we want you to get up and give us the benefit of your experience. By doing this we will gain knowledge from you just as well as you will gain knowledge from us.

At this time I want to thank the individual members of this committee for the extra effort they put forth in preparing their individual papers. As I said before, gentlemen, read every one of these papers, it is going to do you a lot of good. As Mr. Gangewere spoke this morning and as we were told yesterday, the Boiler Maker must get out and get into something that will prepare himself for something better. He isn't going to be a Boiler Maker all his life, at least I hope I won't be. But if you get into your smoke abatement problem, give it study, work on it along with your boiler-making, it is going to do you a lot of good, it is going to do your Railroad a lot of good, and it is going to help the smoke inspectors in the cities where they have smoke abatement ordinances.

Mr. President, this topic is turned over to you.

President Heidel: Thank you, Mr. Gilley.

Topic No. 1 is now open for discussion.

DISCUSSION ON TOPIC No. 1

President Heidel: This is a very live topic, it concerns each one of us. I know that we can get some information here that we can take back with us and put into effect that will probably make our jobs a little bit easier.

I would like to ask Mr. A. A. Raymond, Supervisor of Fuel, New York Central R.R., to come up here and say something to us.

SMOKE CONTROL

MR. A. A. RAYMOND

The majority of railroad men are interested in Smoke Control but it possibly depends on you gentlemen who are thoroughly familiar with ways and means of smoke control to educate the many, many people on the railroad so that they will automatically stop the emission of smoke.

The Cleveland papers have reported considerable progress in control of air pollution; that is, they say that at one time there were 60 tons per square mile per month and that has now been reduced to 42, but you will, I know, agree with me that 42 tons per square mile per month is a very large amount of dirt raining down onto our streets. Of course, only part of this is from coal, but we must, with other people, do everything possible to reduce the amount emitted by the industry in which we are vitally interested.

Public opinion is becoming stronger and stronger on smoke control. For instance, years ago only a few cities had air pollution or smoke

ordinances where now practically every large city has such an ordinance. That is, the public is becoming determined that this remaining 42 tons shall be reduced just as far as is practical.

The public is not insisting that the railroads do anything different from other industries, industries which, we hear from day to day, are spending $100,000, $50,000 or $300,000 to stop air pollution. That is, industry realizes the necessity of such control and are spending substantial amounts of money so that it seems reasonable that the railroads should control their emissions just as far as is practical.

It is interesting to know what some industries which have sulphur gas emissions have found it necessary to do. They have what they call "bag houses" which are a large number of cloth bags through which the contaminated air is passed, the bags removing the objectionable material. Of course, after a time the bags become filled up and they have a duplicate set through which the gasses are passed while the original set are electrically agitated to shake out all the foreign material and get them ready for re-use.

This is just mentioned to show the extent to which industry is going to satisfy the public demand for controlling emissions of obnoxious material of any kind.

What is the railroad picture and what is our own particular angle of it and, specifically, what can the boiler foreman do?

It appears that there are three angles of approach for the boiler foreman. First, when you clean fires with blowers wide open, a large amount of material is thrown out of the stack and you will find while you are cleaning fire that a substantial amount of material is emitted and that it is very high in ash. Then, after the fire is cleaned, it is necessary to put in some coal to rebuild the fire and you will find that if you still leave the blowers on full almost an equal amount of material is ejected, in this case high in B.T.U. and low in ash. In other words, the blowers take a large amount of material out of the firebox. If it was ash, ash comes out—if it was coal, good coal is coming out. At one place we had a crude apparatus for collecting the emissions and we got about three quarts while cleaning the fire and three more while putting in the coal to rebuild. True, this man had the blower wide open and if you could get him to open the valve just a small amount he would reduce his stack emission of foreign material that much.

To catch this foreign material would seem to take a sort of precipitator like they have at the Washington, D. C. Terminal. It is a round pipe that fits over the stack, the pipe extending sideways and down into the wet ashpit and having in it a number of shower bath sprays to wet down the cinders. Thus, the cinders are dumped into the pit and being a wet ashpit the water doesn't affect you. It, of course, is difficult to use such an apparatus where you don't have a wet ashpit because the water runs all over the ground and freezes in winter and is very objectionable.

Washington, however, has a very nice suburban development on the hill above the enginehouse and it is surprising to walk on the streets and see how clean they are with practically no fly ash and you will recall that around some enginehouses the amount of fly ash is very objectionable.

Second, blowing flues. Most railroads are washing flues but there are a few left that are still blowing them and, of course, when you blow flues a certain amount of dirt is again carried out with the blower, and spread widely over the countryside. It seems quite necessary that flues be washed and one of the advantages of washing them is that we have found that flues are much cleaner washed than if simply air blown.

In this connection, it has been necessary to put an air blower through a solidly plugged flue so as to get a passage through it before the water was turned on, and I would like to stir your ingenuity. We can drill a hole in a piece of concrete and surely we can find some way of getting a hole through a plugged flue without blowing air through it and spreading cinders all over the neighborhood.

The third side of the picture is firing up engines—and the engine watchman. Mr. Chambers here in Chicago in the City Hall had a letter the other day received from a railroad about twenty-five years ago when they said they put a notice on the bulletin board that everybody was to fire engines in a certain way, and they wanted to assure Chambers that this would clear up the railroad smoke nuisance. Chambers said "That is twenty-five years ago and I don't know that the fellows have really gotten much beyond first base yet."

Possibly we will partially agree with him and this seems to be particularly in the scope of boilermakers' work. That is, to use the tools that have been developed, such as the air fork, to be sure engines are fired without making objectionable smoke and that the blower is used only as hard as is necessary and that when coal is added to the fire around the enginehouse it is put in with the scoop, a few scoops at a time with as light a blower as is consistent.

Before leaving this subject I know you will all agree with me that every man will do as well as he knows how. He will fire an engine without smoke if he has been taught that that can be done without too much effort. Our problem, yours and mine, seems to be education, the advertising that this can be done, and that there are very simple and practical methods of doing it.

To promote such a campaign the Coal Producers Committee for Smoke Abatement picked out Columbus for some development work and in educating men it was realized that a moving picture would be of the greatest assistance so that all the railroads in Columbus cooperating, at one enginehouse it was decided to make the moving picture of firing up an engine without any smoke and it was found that some railroads had much better systems than others but the general discussion in the roundhouse group produced very beneficial results, even before the picture was started.

Possibly that can be classed as education. That is, the men getting together and discussing various ways and then going out and trying them.

The next picture taken was a yard engine leaving the house and doing some switching in the yard and it is proposed to continue and make a picture of a freight engine leaving the enginehouse and taking a train out of town without objectionable smoke and similarly with passenger engines.

In conclusion, may I leave with you these thoughts. First, the control of emission of cinders and fly ash is a real proposition. Second, whatever we personally may think of it, the public is demanding results and third, in our bailiwick we emit tremendous amounts of fly ash and cinders which, to a very considerable extent, can be eliminated.

Thank you very much. (Applause)

President Heidel: Thank you, Mr. Raymond.

I know that we have heard some facts here that we can put into effect to good advantage — facts that will fit exactly the place where we live as well as the city or state that Mr. Raymond is talking about.

I would like to ask Mr. Christopherson to come up here and say a few words.

Mr. Christopherson: The State of Massachusetts and the State of New York have had Utility Commissioners both on Smoke Abatement and Fire Prevention for a good many years. I was kind of surprised when Mr. Raymond was talking about the Railroads alone. We have some of the smoke abatement inspectors sitting in one of the tallest buildings we have in Boston. Some of the industrial smoke stacks are a darn sight worse sometimes than any locomotive and they don't even see those, but let there be fine black smoke coming out of an engine house and we will have them right on top of our neck. In other words, they will telephone right over.

A good many years back we had a smoke consumer and it helped out. We had very simple ways of getting rid of the smoke by inserting air holes in the door and letting the air go over the fire bed. It helped out considerably and the wonder to me is why we did not keep on with it because it certainly helped.

Also, it was because of the fact that smoke was one of the worst offenders that we adopted the brick arch. The open brick arch in a steam locomotive gave us more smoke than a closed arch. On the hand-fired engine, which we have quite a number of, I did not agree with the closed arch because we had another firebox on the top of the brick arch and plugged all the flues, and we had a darn sight more black smoke than with an open arch, where the coal that the fireman would heave in that firebox, half of it would go on the top of the brick and stay there with a closed arch but on an open arch it would drop down between the flue sheet and the opening of 5 inches that we used to have on the key block between the brick arch and the flue sheet.

On the fire prevention, we have regular inspectors from the State of Massachusetts who cover the Railroads as a whole. They come in to us like any district I.C.C. inspector and they demand to open up front-ends and they will go through them.

We have on the Railroad certain gages that we use during boiler wash periods for worn strands on the netting or holes in the ashpan. Any engine which is caught setting fire we have to take that engine out of service, dump it and give it a cold inspection, and as a rule the utility inspector is at that Roundhouse with us.

In Mr. Desmond's paper he mentioned the fact that in fire prevention the old Master Mechanic front end is probably the worst offender. He also mentioned that there seems to be less trouble when the Cyclone, Thompson or Huron is used with the venetian blinds because whatever coal you bring out through the flues into the front end will go into dust, and I agree with him .

The same utilities in Massachusetts, without my knowledge, sent me a letter and congratulated us on two or three engines which had the Huron venetian Spark Arrestor in the front end for about six years and it was never reported as setting fire. So there are things, I believe, that the Boiler Maker can do to help both fire prevention and the smoke.

We have on our departure track a man assigned to do nothing else but to check up to see that all hoppers on the ashpan are securely closed. In other words, we lock up, we have a locking device, and he has to see before that engine leaves the terminal that the ashpan is closed. We also open up the front door to be sure that all keys are in the netting door.

I thank you. (Applause)

President Heidel: Thank you, Mr. Christopherson.

I believe we have another man who also has written a report on this topic. I would like to call upon Mr. Desmond to say a few words.

Mr. J. J. Desmond: Mr. Chairman and Members of this Association: I am highly honored and pleased with Mr. Raymond's talk of what we have in the Washington Terminal. Smoke abatement to me does not go back for 5 or 10 years, it goes back for 48 years. That is how long I have been handling it and I am in my 49th year now on the Railroad. I can go back to the days 48 years ago when we used coke coming out of Washington.

This setup in Washington has been in existence before I was born. I was highly pleased when he mentioned this smoke consumer, which I did not bring out in my report. It is really a flyash consumer that we have on our fire tracks in Washington. It is really not my idea but my Master Mechanics' idea which he gave to me and I had to carry it out. He gave me the idea of what he wanted and then I had to put the thing together. You know this is one place that we don't have a Mechanical Engineer. The Master Mechanic and I get together and formulate our ideas, and whatever ideas he has I try to carry them out to the best of my ability, therefore we get somewhere. We don't have to ask this fellow or that fellow, if we have a good idea we don't have to sell it to some guy that does not want to hear us. I think that is a good point.

I may say that the locomotives give us a small minority of smoke and flyash compared to power plants. Of course I haven't had a whole lot of experience in power plants but now and then when they get up against something in Washington I have to correct that condition.

We have in Washington a smoke nuisance law. The Citizens' Association is the one that is invariably after the District authorities to combat this smoke nuisance, and, gentlemen, you don't know what it is because we have it all the time. If you just create a small amount of smoke, those people are right after the District government, and they are after us.

As I have always said, I would be pleased to have an I.C.C Inspector or a District Smoke Inspector stationed at our station at all times. That would relieve me of a whole lot of responsibilities. You would get some good work then because the men would be scared to put the engines out unless they were all right. That might take me back to some of you back shop men. Every now and then I have to give those fellows a little dig because when you give us fellows in the Round House good work we are going to carry on that good work, but if you give us bad work then you have created a condition which it is difficult for us to overcome.

Getting back on the smoke abatement again, in this smoke consumer that I have on my fire track, that passes through seven water washes. At the bottom of this I have a 6-inch piece of pipe that goes down into the water, we have an ash track there that is full of water and all the ashes dumped from the firebox go down into the water to put out the fire immediately, so therefore we do not have any particles of flyash. After all, you know smoke isn't what creates objectionable conditions, it is flyash, as far as I have ever found out and I believe, too, that you can eliminate entirely any flyash from coming out of that stack.

Of course there are still some improvements that can be made in that smoke consumer. I did not make it quite high enough so that I could put on a blower. While I have a steam blower in it, it is not sufficient to take off

and do away with the smoke without using the engine blower. If I raise it up where I can have a regulation on that stack and use the blower in there I can eliminate the engine blower entirely, and when I can do that I can completely eliminate smoke and flyash, both.

The thing that I would like to emphasize here are the plower plants. We have a residence section hardly a square away and I have seen an occasion there where you would walk on the street and crush this flyash on the pavement, it was that thick. So in moseying around these power plants I say to the engineer, "How do you clean out the bottom of the smoke stack?" He says, "We clean that out in a few minutes, we just open the base of this door"; and, brother, I'm not kidding, we could fill that place up in three minutes. In the base of that stack there was about 15 or 20 tons of flyash, I mean *flyash,* so they could easily clean it out, especially at night time and according to the way the wind was blowing.

In these power plants we have all of the boilers hooked up to one conveyor and this soot, flyash, etc. step up into stages through this passageway. Then we have one pit there that the first stage is directly under the boiler, I just forget what they call that, but anyway it is staged from there on through the passageway to the smoke stack, then on through the stack. In that first stage you could get, I'd say, anywhere from two to three tons of good, pure, white flyash. Then as we go along through the tunnel we have other places and openings where they clean out, so finally the last stage it deposits the residue at the base of the stack. Now there you are pulling that out with rakes, shovels, and whenever you handle ashes, especially with a shovel, you know what happens. I used to burn coal in my furnace at home, I used to get my ash container and I would throw water in there, but that only penetrates so deep, then I would take a shovel and bring it out ever so carefully until finally I would get to the top of my ashcan, and bump, I would just hit the edge of it and my whole cellar would be full of ashes. There is only one way to take that out and that is to suck it out with a vacuum cleaner, the same way that we take cinders from the top of our Diesel locomotives today. We clean out our boilers on our Diesel locomotives with a vacuum cleaner, we clean all the engines, especially when you double-head a Diesel locomotive and steam engine you get plenty of cinders. That is the only way to eliminate flyash when you remove it.

The smoke consumer which I devised and which we place in all fireboxes we have been commended for from coast to coast, and my Master Mechanic invites anyone that would care to come to Washington to see us perform. We do perform in quite an efficient way. We educate everybody in our shop, not only the supervisors but mechanics, helpers and laborers, everybody is educated to eliminate smoke, and whenever they see smoke emitting from a smoke stack they will go in and call somebody's attention to it or call it to the attention of the fellow who is building the fire.

This smoke consumer was demonstrated at the 1946 meeting of the Smoke Prevention Association in Minnesota somewhere. They went to the station and they created a No. 5 smoke that you could call it 15 if you wanted to. When they placed that smoke consumer of mine inside of the firebox, in 10 seconds that smoke was cleared up.

We had our District Inspectors come to our shop, they are out there quite frequently, and we were using all kinds of things to eliminate this smoke until I got the idea of this device. We demonstrated to them and we made just as black a smoke as we could possibly make and we burned the air on that clam shell mouthpiece of mine and we cleared that up in three seconds. You clear up the smoke but you don't clear the flyash, there may be a small quantity of flyash that will emit from the smoke stack, but I

believe that with the proper use of that consumer and if your fuel tender is taught to use it, and use it religiously, that your fuel trouble will be over as far as getting violations and having any complaints. After all, what we are trying to avoid is having these complaints. Of course, a violation in the District of Columbia is between four and five hundred dollars to the Railroad, which also sets a bad example.

This smoke consumer, I could not use air so I used steam, which wasn't so bad but it wasn't as good as air, and I do believe that if some day somebody could place an auxiliary reservoir on one of their locomotives on the line of road they would reduce the emission of smoke, and in the station they would practically have none. However, we check on all the crews that come in on our ash track. They have got to have a minimum amount of fire in there to bring that engine to the shop after they come into the station with their train because if they lay down in the station any length of time, which they do because a whole lot of them come in there head first and lay there, their fire is going to die down and they have got to do a little rebuilding of the fire. So you can see the importance of coming into the City of Washington with a good fire and having enough fire to bring that engine to the shop without creating a smoke nuisance.

I hope I have given you fellows some food for thought and with the information I have given you I hope you will take it under consideration and get more out of it than what I have done. (Applause)

President Heidel: Thank you, Mr. Desmond. I know that some new ideas have been expressed to which we can give some thought.

I would like to ask Mr. Heigley, District Locomotive Inspector, Interstate Commerce Commission, to say a few words.

Mr. F. R. Heigley: Of all that has been said here this morning, the one fundamental problem in back of the entire smoke abatement problem has not been mentioned. Mr. Raymond mentioned that the washing of flues has been an improvement over blowing flues. That only eliminates the emission of flyash and smoke in the vicinity of the enginehouse. I can cite you one instance in which the flues of the locomotive were washed at the monthly inspection and, due to the inferior quality of coal, the locomotive was forced to give up its train in 24 miles due to no steam, at which time 75% of the flues were honeycombed over solidly.

I am a firm believer that if this Association will work with the Railway Fuel Supervisors Association toward obtaining the proper grade of coal with which to fire the locomotives, 95% of all smoke can and will be eliminated. The one important duty for this Association is to work in close cooperation with the Railway Fuel Supervisors Association toward obtaining the proper type of coal with which to fire the locomotives.

Thank you.

President Heidel: Thank you.

Mr. Fegan, I wonder if you have a few remarks to make. Mr. Fegan is from Canada. Canadian National Rys.

Mr. S. A. Fegan: Mr. President and Members of the Association: My report which you have before you is confined entirely to the locomotive design. I am not going to dwell on that any further. I have given you the measurements of the draft and gas areas, which are common to the conventional construction.

I am like a good many of these other gentlemen, I go back in this work for many years and I am just old enough, also old fashioned enough to believe in my experience and what I see. I think what is required today, apart from everything that has been said, is for the individual companies to adopt any extra appliances that would contribute to the saving of fuel and meet the air pollution problem with which they are confronted.

I don't think I have anything further to say, apart from confirming our locomotive performance in regard to dense or unreasonable smoke. We operate heavy main line passenger and freight trains across thirteen miles of the City of Toronto and the Smoke Inspector advised me that only one violation was dealt with in the past year; this was attributed to carelessness of the engine crew. In road service a daily check discloses that the locomotives can be operated without emitting smoke heavier than a No. 2 density providing it is in a good mechanical condition.

In regard to the flyash, smoke and general air pollution at Terminals from power and heating plants, etc., it is my opinion that the degree of elimination rests with the expenditure involved and necessary to meet the individual circumstances. Ways and means, and different alterations and appliances having been discussed and presented by members of this organization at this meeting which information will be available through the final publication. (Applause)

President Heidel: Thank you, Mr. Fegan.

I would like to ask Mr. Brown, the Air Pollution Control Engineer of Milwaukee County, to say a few words from the public viewpoint.

Mr. Brown: Thank you very much, Mr. President.

As a guest I feel especially honored to discuss the subject with you. I hardly know where to begin with this group of Boiler Makers because as a Boiler Maker I would be classified as a wrecker, in fact, perhaps the third generation of boiler wreckers. Somehow my grandfather managed to explode a vertical tubular boiler which skyrocketed through the plant and roof but survived to retrieve it from an empty lot a quarter of a mile away. As a boiler maker, consider me as a novice.

However, from the standpoint of air pollution control which has become an all too popular subject for various "do-gooders" and "knitting societies", I do hold out for sensible smoke regulation and control.

I don't mean to minimize that in any sense of the word in Milwaukee County we consider that smoke regulation is a subject to be given only lip service. We expect every man to do his duty and by reason of the experience that our organization has had in various phases of operating fuel-burning equipment, we don't take too many "haywire excuses" for answers.

At the present time, the country is facing the possibility that many of the city smoke regulation departments will be superseded or taken over by their counties. This has already occurred in the Milwaukee County, Wisconsin, jurisdiction. A further step is entirely possible where the state may step in and handle the work on a uniform statewide basis. Such things begin to make sense when you consider the fact that a city may clear itself of smoke within its own boundaries yet be completely helpless to do anything about smoke and air pollution which blows in from outside. A rather recent example is that of the city and county of Los Angeles establishing a considerable department for such work. It is, of course, possible that groups of counties will coordinate or merge.

In the brief time alloted me, I would like to outline how the Department of Smoke Regulation of Milwaukee County handles its law enforcement and control program. First of all, we realize we cannot do business or work cooperatively with a man unless we talk to him face to face across a table and discuss mutual smoke abatement problems openly and without any reference to or motive for enforcing a section of the law against him. For that reason we have set up bi-monthly meetings with all of the railroad officials who care to attend it. The meeting is held at the Courthouse and the first order of business at each meeting is to clear up those matters which have occurred since the previous session. Such matters as smoke violations which we consider to be of an unusual nature or particularly severe or for which there seems to be very little excuse are given consideration and an attempt is made to analyze the violation and determine who is responsible for it. From our viewpoint somebody is definitely responsible for any smoke violation which occurs. Determining that responsibility is not always simple. Is it the crew on the engine? Certainly, as far as it is humanly possible for them to control smoke and work cooperatively in doing the assigned work. The railroad management itself? Yes, so far as they can control the situation; obviously management's responsibility is tremendous. However, we still have situations where nobody seems to be especially responsible; in other words, such smoke violations come almost within the classification of "acts of God." These are the difficult ones and at this point there is a distinct need for the department to confer with railroad management, including under certain conditions, the master boiler maker. An attempt is made to analyze the difficulty so that in the future it will be possible to eliminate such causes for violations which otherwise could be classed as only "emergencies" It is necessary also to screen out those cases where replies border on the imaginative, and believe it or not, gentlemen, a crew can "dream up" some beautiful explanations in an informal or formal investigation to explain why their locomotive was putting out a No. 4 Ringelmann smoke for three minutes or whatever the violation was.

In addition to discussing such problems with railroad management, it was also the intention to simultaneously include the brotherhood men in the discussion, especially those who were interested. Remembering previous experience and considering the fact that diametrically opposed interests would not be likely to cooperate, at the same meeting, it was decided to hold entirely separate meetings. It was also obvious that any information which needed to be transmitted to the brotherhood representatives could be handled directly with them by the railroad management group concerned. Experience thus far indictates that most smoke violations were due to defective equipment, which when discovered was promptly serviced, repaired and, in some instances, altered. Cases of "man failure" have been exceptionally rare.

The department gets along with both groups very well by attempting to use sound judgment, and in that respect we have been particularly fortunate in staffing the department with inspectors who have come from fields in which their work now lies. For example, Mr. Flood who is attending this meeting also, had been in railroad service for about twenty-three years prior to joining the county force. I would certainly be at a loss to understand some of the procedures or customs which have been long established in connection with railroad operations in the county if it were not for his personal experience. By that means we manage to "keep our feet on the ground" in the hope that we can cooperatively do the job in a practical manner.

I want to limit my remarks to consume as little time as possible, but in view of the foregoing I should add the following explanation. We use

our own system of formal notification known as the "Returnable Railroad Violation Notice" which notifies the railroad fully that a violation has occurred; it specifies the locomotive number, whether it was inbound or outbound, moving, standing or switching, whether it is a passenger or freight, and likewise where it was, the time of day and date when the violation occurred, and the intervals in which the smoke was produced and observed. This notification form is typed up in triplicate. Two copies (original and second copy) go to the railroad and the return reply is entered by the railroad on the same forms, making use if necessary of the reverse side if the reply is lengthy. In addition, it has become general practice for the railroad to attach copies of shop reports if any mechanical equipment or failure was involved.

An analysis of those replies generally tells us the whole story. Usually no one should be considered entirely blameless. There are frequently extenuating circumstances which are definitely recognized. For example, we know there are times and places where the drivers of a locomotive will slip and the excessive draft will tear up the fire bed, in turn causing smoke of an uncontrolled nature for a certain period of time. We definitely make an exception for that. On the other hand, with a train traveling on straight level track and pulling, say, two-thirds of the rated train tonnage capacity on a bright sunny day in July, we certainly cannot accept "slipping drivers" as being a reasonable excuse. It is expected that the engineer will have sufficient control of the locomotive at all times so that slipping the drive wheels is impossible, particularly so when operating as mentioned and moving at about 25 miles an hour.

All copies of the returnable railroad notices are serially numbered, indexed and cataloged. We have a card record for the engine which includes what class of motive power it is, whether hand-fired or stoker-fired, and any other general description necessary. There is also a card for the fireman and one for the engineer and there may even be one for the road foreman of engines. From the violation notices the information is posted to the cards which immediately indicate who the "repeaters" are, equally for men and equipment. By that process of analysis we can point quite often to the class of locomotive which is troublesome in service and indicate to management what in our opinion is the cause of the trouble. Such data are accumulated and at the succeeding meeting all the accumulated facts are used to analyze causes of smoke and to develop reasonably sound recommendations for changes in maintenance, operation or equipment which will eliminate the probable recurrence.

Generally there is no cure-all for smoke. We know that fuel cannot always be perfect, we know that locomotive boiler firebox operates at a terrific rate of combustion, and that the load is highly variable. These and other conditions must be considered. Under light load or when firing up, some engines will smoke heavily but when fully loaded and hot, will do a beautiful job. The reverse may be true of another class of motive power equipment. However, it is known that this method of cooperation accomplishes infinitely quicker and better results than if orthodox methods of law enforcement are used which might readily resemble legalized jungle warfare carried on in front of an official on the court bench who may or may not be able to understand what it is all about. In passing, it should be added that I was very much surprised to find that two of the judges on the District Court Bench in Milwaukee County are former men with railroad experience. They know a whole lot more about the business of operating a locomotive than the layman would suspect.

One of the factors in which we sought early cooperation in the matter of getting rid of readily controllable and unnecessary smoke and dirt was that

of fire building and maintaining steam while standing. One of the recommended devices was a stack attachment for washing the dust from the flue-gas as it issues from the locomotive stack located at the ash knock-out station. This is readily accomplished by water sprays to wet down the cinders and fine dust and discharge it into a suitable pit. I heard several gentlemen in this morning's session referring to that device. It has been used in many places, may be classified as "good medicine." There are likewise good devices for aiding in building up the fire quickly with a minimum of smoke in the process of getting up steam. All manner of devices have been used for this purpose. Generally, compressed air with fuel oil combined in a light-off torch, together with portable air jets left in the firebox while the engine is on the firing-up track or in the round house, are some of the comparatively simple gadgets which have produced excellent results.

To take care of the "emergency" dispatching jobs where it is necessary to fire up a comparatively cold engine in a big hurry and get it up to top operating pressures and out onto the main line to rescue some Diesel that has gotten stranded in the snow somewhere, requires slightly different treatment. In doing that job it appears we may need to borrow something from recent stationary practice which we think is likely to succeed. Thus far it has been tried only in stationary plants. The material used is a jelly-like substance of the same composition used in incendiary bombs during World War II. Such material is spread quickly and thoroughly over the coal as laid on the grates and is promptly ignited. An intense white heat develops and the coal is ignited quickly. The material cannot be extinguished easily and definitely the flame cannot be blown out. We believe that the heaviest road power so lighted off and fired and with the stack blower in operating condition, can place such an engine out on the ready track and in service within thirty minutes, if necessary. Realizing that a 500 HP boiler in a stationary plant can be placed on the line in 42 minutes in comparison with ordinary starting methods requiring 2½ to 3 hours, indicates that the procedure is likely to succeed. From the smoke abatement viewpoint, it makes good sense.

Flyash and spark emission in the open country are still unsolved problems. Several railroads have tried various devices to get rid of them. The Norfolk & Western Railroad engaged in commendable pioneering efforts in attempting the use of an induced draft fan instead of the usual exhaust steam draft stand. On the first trial the cinders promptly eroded the fan blades to a condition of rapid failure in a matter of some three weeks operating time. What is most important is not that the attempt failed but that the railroad is still trying. It is possible to borrow a number of sound ideas for and from the railroad, marine and stationary steam power plant practices if the fundamentals are sound. That is precisely what we frequently do in the smoke and air pollution elimination business.

Perhaps the most important factor to emphasize continuously through any smoke abatement program is as follows: First of all, smoke abatement is in the interest of the entire public, which includes ourselves. We are not on one side of the issue and the general public on the opposite side; furthermore, the program is not something that has been dreamed up by a group of reform promoters. Smoke and air contamination elimination is a present day necessity which perforce has been enacted into law. When we consider the fact that public laws generally lag behind public opinion and progress (technological progress in particular by at least fifty years), we can see why, in all the communities we are hearing so much about, that the foundations for such smoke abatement activities were laid many years ago. That is generally the way laws are developed.

Secondly, it is important to keep an open mind at all times so that we

do not close the door on Theory, Practice or Experience. We can often adapt something that is extremely useful in connection with boiler work and combustion as it relates to locomotive smoke control from each or any of those above mentioned general reservoirs of information. The fundamental principles are natural laws which when properly fulfilled produce the same satisfactory results any time and in any place.

Thank you very much for the privilege of presenting the foregoing discussion.

President Heidel: Thank you, Mr. Brown. (Applause)

Any further discussion of this topic?

Mr. Christopherson: Before I left home I received a letter from a man who is quite an outstanding man on front-end arrangements and draft arrangements. As I understand him, the B. & O. has this equipment now on test. I wonder if there is anyone here from the B. & O. who could tell us a little bit about the outcome of that test.

President Heidel: It appears that there is no one here to answer your question. We will try to get that information and put it in the Proceedings.

Topic No. 1 is closed.

We will have a report now on "Advantages of Steam Space Spray Boiler Checks or Top Boiler Checks Versus Side Boiler Checks," by Mr. K. D. Relyea, Test Department, New York Central System.

Mr. Stiglmeier, will you introduce Mr. Relyea?

Secretary Stiglmeier: Gentlemen, the reason for having the Top Boiler Check report, is due to the fact that the Mechanical Division, of the A.A.R., has asked this Association to appoint a committee on this most important subject, and present a report at this meeting, on the advantages and disadvantages of the Top Boiler Check, however, it really was too late to appoint such a committee to work up such a committee report on this subject. This was discussed with the Officers of the association. It was their opinion that the better procedure to follow would be to get someone to present an introduction of the top boiler check by some certain railroad or individual, and then for the year of 1950 continue on with a committee.

It was proposed to Mr. F. K. Mitchell, Manager of Equipment, of the New York Central System, to see if he had any objection to my asking our Test Department to submit a report on the results of the Top Boiler Check of the New York Central System. He gladly gave his approval, and our Mr. W. F. Collins, Engineer of Tests, selected a Representative of his Department, Mr. Relyea, to prepare such a report. It is my opinion that we should have much discussion on this subject, unless there is someone that has a certain question to ask, this in view of the fact that we are going to ask the Executive Board to make this a topic for the year of 1950.

It gives to me much pleasure to introduce Mr. Relyea, who will read his report on the observation that he has followed on the New York Central System, of the Top Boiler Check with spray nozzle. Mr. Relyea.

ADVANTAGES OF STEAM SPACE SPRAY BOILER CHECKS OR TOP BOILER CHECKS VERSUS SIDE BOILER CHECKS

Report by Mr. K. D. Relyea
Test Department, New York Central System

The patching and renewal of Firebox Side Sheets has been a major item in boiler maintenance for many years and has been a subject of intense research by the members of this association.

The experience of the New York Central has not been materially different from that encountered on other roads. It had been necessary to renew firebox side sheets at every shopping period and a large number of our locomotives have had to receive large patches between shoppings.

In the years 1940 through 1944 we accepted delivery of 115 new Mohawk type locomotives, the majority of which were for combination freight and passenger service. The boiler construction was the same for all with slight variations in cylinder and wheel diameters. While firebox troubles had been with us for many years, this group of locomotives after a short time in service, developed early side sheet failures.

One locomotive of this class after accumulating approximately 28,000 miles of service since construction developed wavy side sheets and leaking bolts. Several others required patches well under 100,000 miles and practically all required new sheets at approximately 120,000 miles.

Metallurgical examination of many sections of these failed sheets usually revealed the same result, that failure was due to fatigue cracks, particularly in the fire region.

These side sheets were purchased by the A.A.R. M-115 specifications for firebox steel. We went back to the original analysis of the steels, the inspection reports, our water treatment, washout practices, the method of making the staybolt holes and cylinder and feedwater pump lubrication practices, all in an effort to determine, if possible, wherein lay the answer to these failures.

The subject was given much thought and study by our engineering and maintenance divisions in conjunction with the manufacturers of the feedwater equipment.

Three courses of action were decided upon:

(1) The reduction of the amount of oil to the boiler by the strict regulation of the mechanical lubricators and the removal of the feedwater pump exhaust from the heater to the atmosphere on five locomotives.

(2) A trial application of alloy steel firebox sidesheets, and

(3) A trial application of a top boiler check and spray nozzle.

It was felt that these three approaches to the problem would yield the answer as to whether it was oil deposits in the boiler, firebox steel or coldwater entrance into the boiler.

The reduction of oil to the boiler gave some indication of improvement but was not the answer as patching and renewing of side sheets continued.

The application of alloy steel side sheets was made to ten locomotives of the "Mohawk" class in 1945. Application was made to alternate sides of the locomotives with the opposite sheet of standard A.A.R. M-115 steel. Four applications were made of manganese-vanadium to ASTM A-225-39T,