

# MUNICIPAL ENGINEERING

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WOOD BLOCK PAVING ON HEAVY TRAFFIC BUSINESS STREET.

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*I'm now arrived—thanks to the gods!—  
Thru pathways rough and muddy,  
A certain sign that makin' roads  
Is no' this people's study;  
Altho I'm not w' Scripture cram'd,  
I'm sure the Bible says  
That heedless sinners shall be damn'd  
Unless they mend their ways.*

—ROBERT BURNS.

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# AMERICAN SOCIETY of MUNICIPAL IMPROVEMENTS

ABSTRACTS OF PAPERS PRESENTED AT THE OCTOBER  
CONVENTION AT BOSTON.

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*So many excellent papers were read at the convention of the American Society of Municipal Improvements that it is impossible to use them all or all of any considerable part of them in this number of MUNICIPAL ENGINEERING. The selections made are grouped together and show the breadth of the field covered. All of the proceedings will appear in the annual volume published by the Society.*

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## Inflammable Wastes in Sewers.

By N. S. Sprague, Superintendent of Construction, Pittsburgh, Pa.

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*There have been many explosions in sewers in recent years, of but few of which definite information is available. Pittsburg has had its full share of serious troubles of this sort and the author has made a careful study of the subject. The results of his inquiries of other cities are given in a pamphlet printed by his department, and the application of the information gained to the problem of prevention of explosions is given in this paper.*

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THE author presents this paper with the hope of eliciting discussion upon this subject by those charged with the responsibility of the design, maintenance and operation of sewerage works, which may throw some light upon the ultimate solution of the problem of regulating the discharge of inflammable and explosive wastes into sewerage systems and preventing sewer explosions.

It is thought that some of the more recent and violent explosions were caused by the presence of gasoline vapor in the sewer and if this belief is accepted as a fact, then the advent of motor driven vehicles has created a problem in sewer design and maintenance which may prove difficult and expensive to solve. Sewer

systems are generally looked upon by the average person as a quick and easy means of disposing of any or all waste matter which can be carried away by the sewer without any consideration whatsoever of the effect of such discharge, either upon the structure itself, its maintenance or operation. The transition in the mode of travel from horse-driven vehicles to the motor-driven car and truck, renders the transportation, handling and use of large quantities of gasoline necessary and it is inevitable that in the handling of this material some will be spilled or wasted, either by accident or design, which will find its way into the sewers.

There are many sources which contribute inflammable wastes in a greater

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or less degree, ranging from the small and irregular discharges from households and private garages, which may amount to considerable in the aggregate, to the large and intermittent discharges from manufacturing and storage plants and other enterprises which use large quantities of gasoline.

In some cities (Pittsburg included), the laws relating to the storage of gasoline require the tanks to be buried in the ground. These tanks, which are made of riveted steel plates, vary in capacity from about 50 to 15,000 gallons. The purpose of placing them underground is to prevent possible ignition of the gas and protect them in case of a nearby fire. It is not the author's intention to discuss the advisability or the objection to placing gasoline storage tanks underground, but simply to point out the possible danger of gasoline escaping from these tanks and entering the sewers. The thickness of the steel plates of which the tanks are made, is generally from  $\frac{1}{8}$  to  $\frac{3}{16}$ -inch and their only protection from corrosion is the application of ordinary structural paint. The tanks are laid directly upon the ground and then covered with earth. Under such conditions, corrosion is rapid. It is also possible, under favorable conditions, that the tanks may suffer injury due to electrolytic action. In any case, there is no opportunity for inspection or repairs and leaks can only be detected by making a comparison of the quantity of gasoline put into the tank with the quantity removed. This information is in the possession of the owners and in case a leak is disclosed by a comparison of the figures, the owners are not likely to volunteer the information to the public authorities.



**¶** LEAKAGE from underground sheet metal gasoline tanks is certain. That this leakage will reach near-by sewers is quite probable.

The possibility of gasoline escaping from the tanks into the ground and finding its way into the sewers, may be remote, but with pervious soil or a near-by catch basin or trap, the opportunity for leakage into the sewers is at least present.

In certain locations it is quite possible to set these tanks above ground, where ample opportunity for inspection and repairs would be possible. The waste gasoline from households, private garages and shops, is so well distributed thruout the lateral sewer system and the average amount discharged at any one time so small, that it is quickly dissipated before the formation of explosive vapors can occur. It is, therefore, to be supposed that the formation of gasoline vapor and other explosive gases present in sewers originates from establishments which are large users or dealers in inflammable materials.

There being in most cases no laws prohibiting the discharge of inflammable wastes into the sewers and the danger of such practice not generally understood, the natural disposition of such wastes is into the sewers. Those wastes comprise dirty and used gasoline, benzine, oil, washings from tanks, and refuse from gas plants, paint works, etc. The quantity of these waste products varies according to the magnitude of business and methods employed.



**¶** WASTE PRODUCTS of other kinds than gasoline may produce explosions and they must be regulated also.

While the discharge of gasoline into the public sewers probably exceeds in quantity any other inflammable waste, yet the discharge of waste products from paint works, oil refineries, gas works, etc., is likely to produce conditions, which, under favorable circumstances, may fill the sewer with explosive gas. Ignition of explosive gases, when present in the sewers, may occur in many different ways—for instance: Sparks from street railway tracks, hot cinders and sparks from locomotives, stacks, etc., which may enter the manholes thru the perforations in the covers, or when same are removed for inspection or repairs; also the dropping of matches or lighted cigars into manholes or catch basins; lights and sparks from tools, while making inspection or repairs within the sewer or at chambers, pumping stations or disposal plants.

The problem of preventing sewer explo-

sions would then seem to be a question of either effectually sealing all openings into sewers or excluding or regulating the discharge of inflammable or explosive wastes.

A number of cities have attempted to solve the problem by procuring legislation prohibiting or regulating the discharge of inflammable waste materials into the sewers. Prior to the general use of motor vehicles there were many industrial and business establishments using inflammable and volatile wastes, such as dry cleaning establishments, paint manufactories, gas works, etc. Notwithstanding the fact, explosions in sewers caused by the ignition of gasoline vapor were uncommon. This fact would seem to indicate that the greatly increased use of gasoline due to the growth of the automobile industry has been responsible for many of the recent sewer explosions.



**¶** CONTROL OF DISCHARGE of gasoline into sewers is easy if from large sources, difficult if from many small sources.

Accepting this theory as a working basis, we must determine whether or not the gasoline is discharging into the sewers in large quantities by a relatively few people or in small quantities by a great number. In the first case the situation is relatively easy to control, while in the latter, it would be difficult. Moreover, it is necessary and important to determine whether the explosive vapor is generated from the accumulative effect of a great number of small discharges or from the discharge of large doses. Past experience has shown that the ordinary means of providing ventilation in sewerage systems has been generally adequate to prevent the collection of explosive gases. If large doses of inflammable wastes are allowed to enter the sewers, other means of ventilation will have to be provided or the sewers sealed. The installation of mechanical ventilation in the sewers thruout the system would remove the gases, but would involve great initial outlay and the cost of maintenance and operation would generally be prohibitive. This scheme would not seem practicable. There is no practical way of pro-

viding sufficient ventilation, either by mechanical or natural means, which would exhaust the air inside the sewer quickly enough to prevent the formation of an explosive compound, in case large quantities of gasoline were present in the sewer. With the exclusion of large discharges of gasoline into the sewers, the danger of explosions can be greatly lessened by giving more attention to the improvement of the natural ventilation. This would probably be sufficient to prevent the collection of explosive vapors arising from the normal amount of gasoline discharged into the sewers. To form an explosive mixture a certain amount of air and gas is required. If there is a shortage of gas or an excess of air, no explosion can occur.

It cannot be ignored that many sewer explosions have resulted from the leakage of natural or artificial gas into the sewers. Evidence has been conclusive, in a sufficient number of cases, to show unmistakably that this is a fact. The prevention of explosions from this source, however, is well within the jurisdiction of public officials and the remedy is the tight construction of sewers and proper laying and location of gas pipes. The remedy in this case consists, therefore, is in the enforcement of powers that municipalities at present possess.



**¶** VENTILATION and inspection are aids, but so far have been insufficient to control the situation.

Modern sewer design provides for the ventilation and inspection of the structure. The discharge of inflammable wastes into sewer systems would not of itself be a serious matter, or objectionable, were it not for the possibilities of igniting the explosive compounds. Ignition of gases in the sewers could be prevented by sealing all openings, but this would prevent inspection and create impossible working conditions inside the sewer when repairs became necessary. Moreover, the sealing of the sewers would not prevent ignition at chambers, pumping stations and disposal plants. In addition to the foregoing, there are other reasons which would make

the sealing of the sewers impracticable and inadvisable.

The exclusion of inflammable wastes from a sewer system brings up the question of how it shall be accomplished. The regulations of the Municipal Explosives Commission of the city of New York, adopted January 3, 1912, require the installation of oil separator traps or similar apparatus. The city of Boston requires a special trap which will prevent the discharge of the objectionable wastes into the sewers, and the city of Chicago has somewhat similar regulations to those of New York, governing this matter.

The efficiency of these devices is dependent upon the attention paid to their operation by the individual. Careless operation or neglect might render them of little value and defeat the purpose for which they were installed. Therefore, frequent inspection should be made by the proper public officers. Their general use on all sewer connections where gasoline or other inflammable waste is discharged would seem prohibitive, if found otherwise advisable, on account of the cost. The compulsory installation of devices for removing oil will generally meet with opposition by those affected, which has been recently demonstrated by the passage of an ordinance in New York City repealing the ordinance requiring the installation of oil separators. I am informed that this repealing ordinance was vetoed by the Mayor.



**¶** LEGISLATION on the subject must be most carefully formulated if it is to be effective.

Formulation of legislation directed toward the prohibition of the discharge of inflammable wastes into sewers is at present receiving attention in many cities. That the same may be effectual requires the most careful consideration. It is most desirable that the necessity for such regulations be demonstrated and the efficiency of any device thoroly proven before they are required by ordinance.

The writer has examined the regulations of a number of cities and has come to the conclusion that it would be best

from the standpoint of enforcement, to have all regulations of this nature contained in a single ordinance which would cover all phases of the discharge of wastes of all descriptions into the sewers. Such an ordinance should contain the following:



**¶** GENERAL PROVISIONS of ordinances designed to prevent sewer explosions are briefly stated.

A. Prohibition against the discharge of any inflammable gas, volatile inflammable liquid, inflammable liquid, oil or gas, or any calcium carbide or residue therefrom, or any liquid or other material or substance containing inflammable gas or which would evolve an inflammable gas when in contact with water or sewage.

B. Regulations as to how sewer connections with establishments from which the foregoing wastes emanate may be made. This may, or may not, require the installation of special traps, separators or similar devices.

C. Provision for the examination and approval of all intercepting devices and provision for their inspection, maintenance and operation.

D. Provision with regard to the discharge or placing of obstructing material in any part of the sewer system.

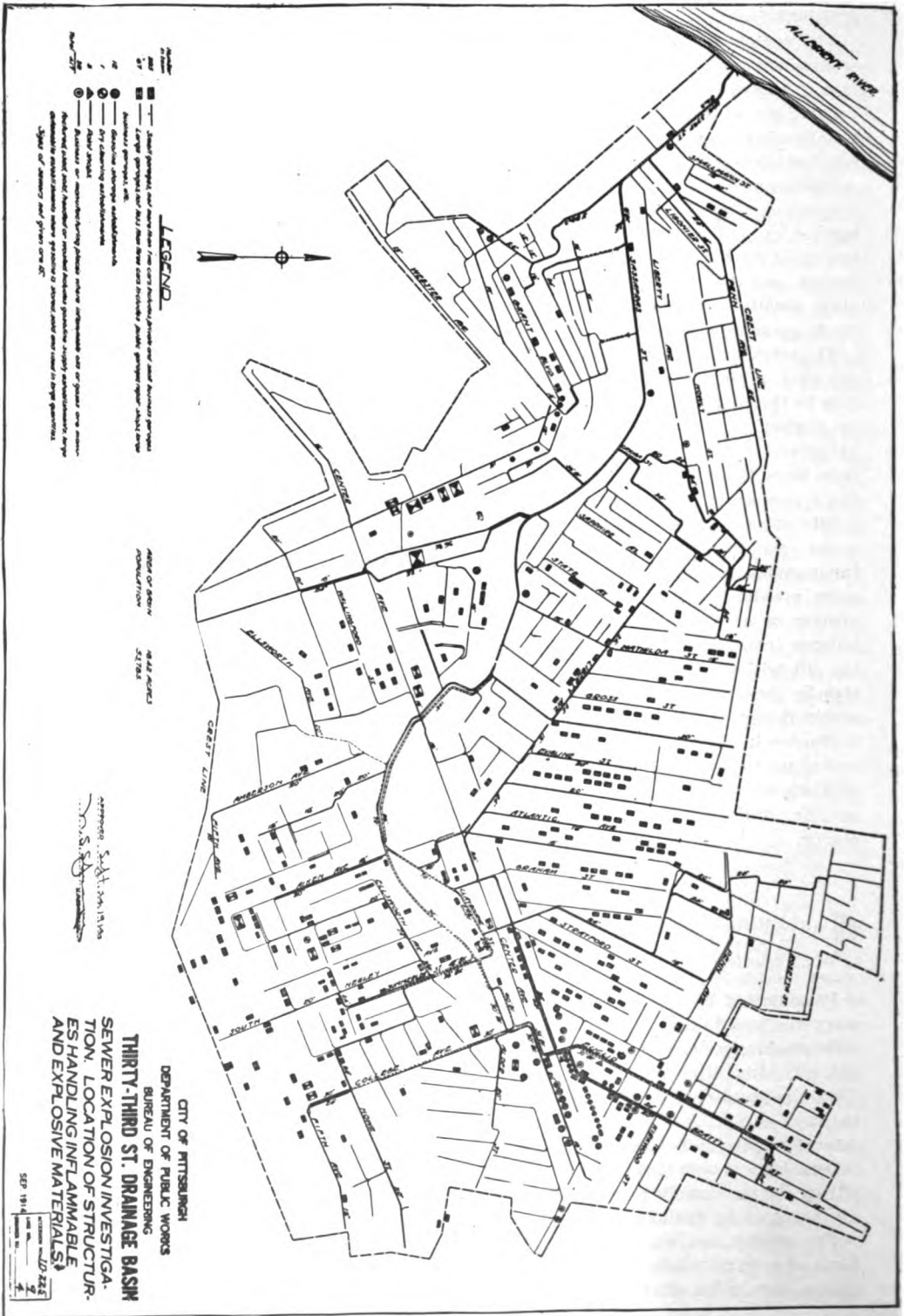
E. Regulations as to the discharge of steam or hot liquid or gaseous waste into the sewers.

F. Regulating the location of gas pipe in city streets with reference to the sewer; prohibiting the placing of gas pipes close to or within the masonry of sewers.

G. Prohibiting connections from man-holes, gate boxes, or other apparatus of public service corporations to the sewers, except in an approved manner and when properly trapped.

Legislation alone will not secure or prevent the discharge of these objectionable wastes into sewer systems, but by informing the people of the damage resulting from this practice, the offense will be greatly lessened.

It would appear desirable, in the interest of public safety, where oil separators or similar devices are installed, for the



municipality to undertake the final disposition of the residue rather than entrust it to the individual. The importance of the problem and the necessity for its strict and effectual regulation has been amply and forcefully demonstrated by recent violent and destructive explosions.



**¶** *SERIOUS EXPLOSIONS in Pittsburgh sewers have occurred in the past year, and others in other cities are only less serious and less expensive.*

As recently as September 22, another serious explosion occurred in Pittsburgh in the sewer on East 42nd street, between Third avenue and the East river, making the third explosion in the same sewer within a year. Reports state that the physical damage to the sewer, buildings and street, was not extensive. This is accounted for by the fact that the sewer was a brick lined tunnel in rock about forty feet below the street surface. Under less favorable conditions of location and design this result would have been far more serious.

The most disastrous and expensive sewer explosion up to the present time, altho entailing no loss of life, occurred at Pittsburgh, Pa., November 25, 1913. This explosion to date has cost the city about \$300,000, which may be increased by possible damage suits.

This problem is not confined to the prevention of explosions in the sewers themselves, but may extend to all kinds of sewerage works, as shown by the explosion in the screen chamber at East Boston, which occurred June 1st, of this year. In this explosion, which was caused by the presence of gasoline vapor, six lives were lost and three men severely injured.

Without mention of other recent sewer explosions, it is evident from experience covering many cities, that an immediate, effectual and permanent remedy must be found to control the situation. With three explosions in the 42nd street sewer in New York and two in the 33rd street sewer in Pittsburgh, all within less than a year of each other, there can be no question but what the conditions inside of all large sewers draining garages, etc., are such as

to produce explosions whenever ignition occurs. The safety of the public and the welfare of the community are, therefore, now dependent more upon good fortune than the certainty of scientific control, hence the public is always exposed to the hidden danger which only requires a chance spark to cause havoc and disaster. The present situation can be likened to the man sitting on a keg of powder.



**¶** *INVESTIGATIONS with a view to future prevention are now in process by the city and the U. S. Bureau of Mines.*

The city of Pittsburgh, immediately after the second explosion, set about to make an investigation and study with a view of preventing a repetition of such disasters. This investigation is being conducted jointly by the city and the local office of the U. S. Bureau of Mines, who have rendered valuable assistance and advice.

The purpose of this investigation, which is still in progress, is:

First. To locate all possible sources from which gasoline or other explosive wastes might enter the sewers.

Second. To determine, by a series of examinations and tests, the location of the sources where the waste was discharged.

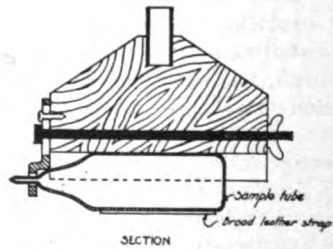
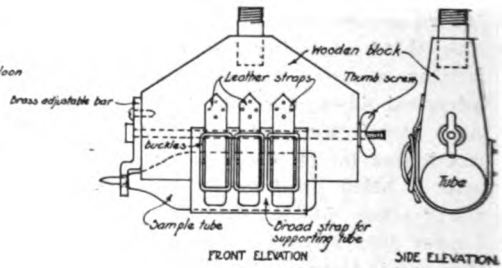
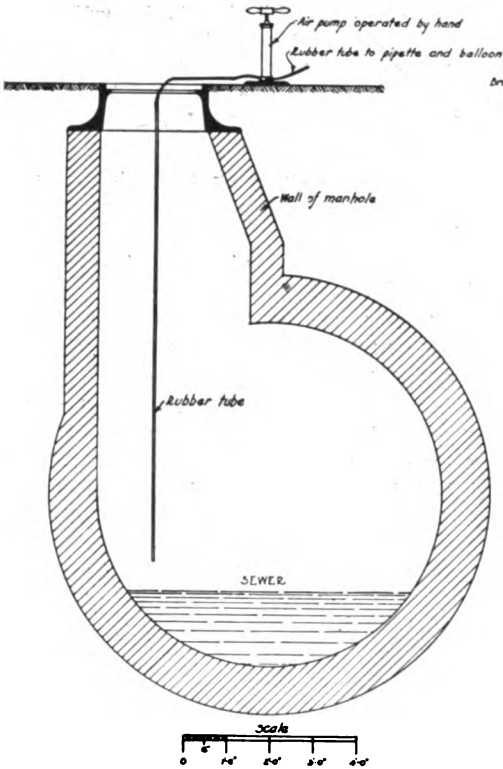
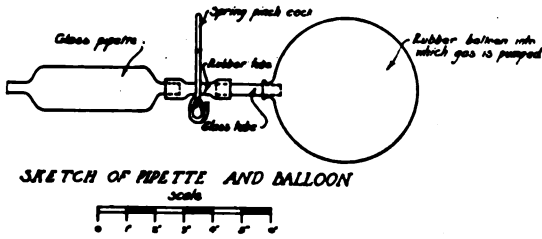
Third. The determination of the presence, extent and quantity of vapor within the sewers.

Fourth. Experiments to determine the effect and behavior of gasoline dumped into the sewer in different quantities and at different intervals.

The 33rd street drainage basin was selected for study because of the number of garages within the basin and the fact that two explosions have already occurred, indicating the discharge of large quantities of explosive waste into the sewer.

The 33rd street drainage basin has an area of 1,642 acres, a population of 53,785, and a total of 417 structures where inflammable and explosive materials are handled. These structures are classified as follows:

Two hundred ninety-five small garages,



**SKETCH OF APPARATUS FOR COLLECTING GAS SAMPLES FOR ANALYSIS**  
Scale



CITY OF PITTSBURGH  
D. P. W.  
BUREAU OF ENGINEERING  
SEWER EXPLOSION INVESTIGATION  
APPARATUS FOR TAKING SAMPLES OF AIR  
INSIDE OF SEWER  
OCT 17 1914

not more than two cars, includes private and small business garages.

Sixty-seven large garages, not less than three cars, includes public garages, repair shops, large business garages, etc.

Twelve gasoline storage establishments.

One dry cleaning establishment.

Two paint shops.

Thirty-nine business or manufacturing places where inflammable oil or gases are manufactured, used, sold, handled or washed; includes gasoline supply establishments, large automobile establishments where gasoline is stored, sold and used in large quantities.

A map was prepared showing the outline of the basin, the sewer system within and the location of all garages, dry cleaning establishments and other places where inflammable or explosive wastes are likely to be discharged into the sewers. The map will be used in connection with studies to locate the point or points where the discharges of inflammable wastes occur.

Letters of inquiry were sent to all the principal cities in the country with a view of obtaining data and information relative to sewer explosions and what laws or ordinances were in force regulating or controlling the discharge of inflammable or explosive wastes into the sewerage systems. The answers received in reply to these inquiries were compiled and have been printed in pamphlet form and copies furnished to each city supplying information.

Apparatus was designed for securing samples of air within the sewer and for making field tests of same. The apparatus used is shown upon the accompanying plan.

The results so far secured in the investigation indicate the presence of gasoline vapor in the sewers of both the 33rd street and Negley Run systems. This latter system drains an area of about 2,500 acres with a population of about 50,000 and there are considerably less sources from which inflammable wastes are discharged than in the 33rd street system. Analysis of a series of samples taken on the same

day at various points in these systems have shown that gasoline vapor in small amounts is present thruout the sewer system. The gasoline vapor ranges from 0.012 to 0.065 per cent. of the volume of sewer air in the sample. While these percentages of gasoline vapor are considerably below the danger mark, which may be taken as 2 per cent., it goes to show that the natural ventilation of these sewer systems is not sufficient to remove the effects of the ordinary or normal discharge of gasoline.

The Negley Run system drains thru duplicate outlet sewers for a distance of over a mile, during which distance there are no connections known which could by any possibility discharge gasoline. Above this point, there are a number of large branch sewers of considerable length so that taking these larger sewers of the system together with the many miles of laterals, with the opportunity for ventilation provided, it must follow that natural ventilation would not suffice to remove the effects of the discharge of gasoline in large doses.

It is expected that these experiments will require considerable time before definite conclusions can be reached and preventive measures, based upon same, can be formulated, but it is hoped that some plan or action can be devised which, without imposing hardship or undue expense upon the people, will secure to them freedom from the peril and danger to which they are now constantly exposed.

[The accompanying map shows the Thirty-third street drainage basin and the large number of small garages containing not more than two cars, and the relatively small problem in taking care of larger sources of materials liable to produce explosive mixtures in sewers.

The page of drawings shows the rubber tube let down to the level from which air sample is desired; air pump to draw the gas up; pipette and balloon to receive the gas; also glass tube for receiving samples and apparatus for handling it.]