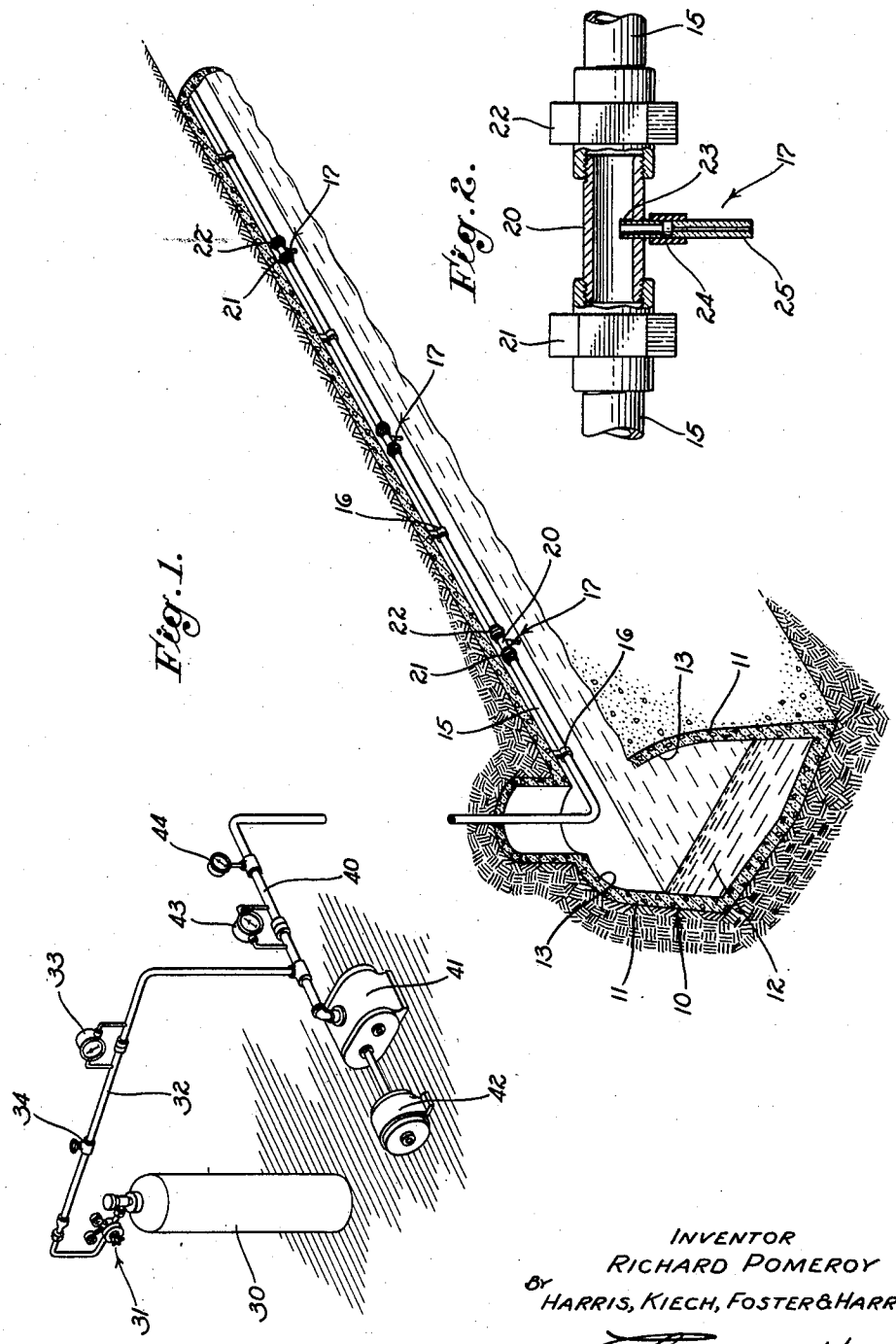
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METHOD FOR PREVENTING CORROSION

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METHOD FOR PREVENTING CORROSION

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This invention relates to the maintenance of sewers and similar structures which enclose or contact a gaseous atmosphere of such character as to directly or indirectly lead to the corrosion of structural surfaces in contact with said atmosphere, and relates more particularly to a method and device for the continued neutralization of corrosive acids in said atmosphere and/or on said exposed surfaces.

In a sewer system, the flow of liquid sewage normally constitutes a stream having a cross section only a fraction of that of the sewer. The remaining space is occupied chiefly by air, which has access to the sewer at manholes, vents, etc.

In instances where the sewer is constructed of a material such as concrete, which is susceptible to corrosion by acids, continued service is found to give rise to extensive destruction of surfaces which are in contact with the enclosed atmosphere. For example, a reinforcd concrete pillar forming part of a manhole structure was found after four years' service to have been reduced to about half of its cross section by "atmospheric" corrosion, both the concrete and the reinforcing bars having been cut through by this type of corrosion. Samples of pasty disintegrated concrete from this and neighboring structures showed a surprisingly high sulphuric acid content, as high as 7% based on the moisture content.

I believe that these effects are due to the evolution of gases from the sewage, which gases, either in their original form or as subsequently modified, are responsible for the observed acidic corrosion.

The liquid sewage itself is rarely acidic and is, for the most part, neutral or slightly alkaline. As a result of changes naturally occurring in sewage however, this liquid is continually giving off gases, including acidic gases such as CO_2 and H_2S. Some of the observed corrosion may be due to the direct action of these gases. In the case of H_2S, moreover, extensive oxidation, apparently through the medium of aerobic bacteria located on the exposed wall surfaces, leads to the formation of much stronger acids such as H_2SO_4. The extent of this process may be judged from the case of a nine and one-half foot sewer in which extensive tests showed that over 6000 pounds of sulphuric acid were formed in each mile of sewer per year.

Various methods have been proposed for "sulphide" control of sewage, including chlorination, treatment with metallic salts, etc. These methods are designed to reduce the sulphide ion concentration of the sewage, and if this concentration is brought sufficiently low, the corresponding vapor pressure of H_2S may be made negligible. There are, however, two major defects in the use of such methods for control of "atmospheric" corrosion.

The first difficulty arises from the fact that a substantial sulphide ion concentration develops again quite rapidly subsequent to treatment and, hence, a treating station at the beginning of a two or three mile stretch of sewer may have little or no effect on corrosion at the lower end of the sewer.

The second difficulty is mainly one of expense and inefficiency and arises from the fact that the H_2S evolved into the atmosphere of the sewer represents only a minute fraction of the sulphide content of the liquid sewage. Consequently, the conventional chemical treatment of the sewage requires far more chemical reagent than would be required for the control of the evolved H_2S were the latter isolated.

It is an object of the present invention to provide a method and device for the control of atmospheric corrosion in sewers and similar conduits enclosing gases which are corrosive to exposed surfaces, and for the protection of structures generally which have surfaces exposed to an acidic of acid-engendering atmosphere.

It is a further object of the present invention to provide a method and apparatus for the neutralization of corrosive acids in the atmosphere or on exposed surfaces in the interior of a sewer or other conduit, and further, to provide a method of the kind described which affords assured protection throughout the entire system which it is desired to protect, and which is relatively cheap and efficient and which is directed primarily to treating the immediate source of the corrosion difficulty, namely, the acids in the atmosphere or on the surfaces exposed thereto, rather than to treating the much greater mass of sulphide in the liquid sewage.

These objects are attained in accordance with the present invention by injecting an alkaline fluid, preferably gaseous ammonia, into the atmosphere of the sewer or conduit, preferably at a number of points, or into a corrosive atmosphere in the vicinity of exposed surfaces which it is desired to protect.

Further objects and aspects of the invention will become apparent in the following discussion, made with particular reference to the attached drawing, in which:

Fig. 1 is a partially broken perspective view of a sewer equipped with means embodying my invention; and

Fig. 2 is a section showing detail of Fig. 1.

Referring to Fig. 1, 10 is a sewer having walls 11 which, in their lower portion, define a passageway for a stream 12 of liquid sewage and, in their upper portion, have interior wall surfaces 13 which are subject to the corrosive effect induced by the atmosphere enclosed within the sewer and lying above the liquid stream 12.

A pipe 15 is suspended from the top of the sewer by means of brackets 16 and carries a number of injection nozzles or orifices 17 adapted to inject a pressured neutralizing fluid into the atmosphere of the sewer for the protection of exposed surfaces, such as the interior wall surface 13.

The orifices or nozzles 17 may be of any suitable design, one specific form being illustrated in Fig. 2. In Fig. 2, 20 is a short section of pipe which is shown fitted into the general run of pipe 15 by means of unions 21 and 22, although ordinary couplings may be used if desired. Section 20 is provided with a short tube 23 which transpierces the wall of the pipe 20 and projects therefrom both externally and internally. A rubber sleeve 24 is mounted on the external projection of tube 23 and serves as a connecting means to a glass capillary 25, the length and bore of the capillary 25 being calibrated to give the desired rate of flow of injected neutralizing medium.

Under most conditions of service, such small quantities of neutralizing fluid are required that such a fluid is best injected in diluted form. For example, where gaseous ammonia is employed as a neutralizing agent, it may be diluted with compressed air. Equipment suitable for supplying the pipe 15 with a mixture of compressed air and gaseous ammonia is shown in Figure 1, and comprises an ammonia gas-supply tank 30 equipped with a pressure reduction valve 31 leading into the ammonia flow-line 32 provided with a flow indicator 33. A valve 34 is provided in line 32 to regulate the flow therein. The pipe 32 empties into a pipe 40 to which is supplied compressed air by means comprising a blower 41 and an electric motor 42. The admixed air and ammonia are passed through a flow meter 43, and a pressure gauge 44 is provided to indicate the pressure in line 40. The pipe 40 serves as a feed for the pipe 15 by means of connections not fully shown but which may conveniently include a pipe means descending through a manhole or other conventional opening in the sewer 10.

In order to maintain the desired pressure in the pipe 15, the far-end thereof is maintained closed and, if the pipe 15 is of substantial length, the down-stream portions thereof may be considerably reduced in diameter in accordance with the lessened flow requirements in that portion of the system.

The operation of this device is as follows: The flow of ammonia from the tank 30 is adjusted to that value which is deemed adequate or necessary for protection for the length of sewer serviced by the pipe 15. In general, this rate will at least equal the rate of sulphuric acid production in the sewer and, for best results, should be several times its value.

When the quantity of ammonia thus employed is relatively small, it is diluted with air to obtain a volume which can be handled and injected at the plurality of injection points with the desired accuracy. The discharge points are positioned at intervals sufficiently close that the zones of protection around each injection point will to some extent overlap, thereby insuring adequate protection throughout the sewer. The size of the individual zones will depend upon, among other things, the rate of H_2S evolution by the sewage or the rate of sulphuric acid formation on the walls of the sewer, the rate at which ammonia is injected into the sewer atmosphere, and upon conditions naturally present in the sewer and controlling the rate of diffusion and/or convection of ammonia throughout the atmosphere and ultimately to the surfaces which it is desired to protect.

There may be some neutralization in the gaseous phase to form ammonium carbonate, ammonium sulphide, and similar salts, although in most instances the concentrations involved will be so low that the acidic and alkaline components of the atmosphere will remain dissociated. Either the ammonia or ammonium salts will serve as an active neutralizing agent for strong acids, however. As a result, any sulphuric acid present or formed on or in the wall surfaces, such as the surface 13 of Fig. 1 will be rapidly neutralized by the absorption of ammonia or ammoniacal compounds with the formation of ammonium sulphate which is much less detrimental to the structure than the unneutralized sulphuric acid. Similarly, the presence of ammonia tends to decrease any corrosive action due to the presence of hydrogen sulphide, carbonic acid, or other gaseous acids.

Various modifications of the described embodiments and methods may be made, including those specifically mentioned in the following:

Various fluids having an alkaline reaction may be employed for the protection of the sewer in accordance with my process. In general, it is preferable to employ a gaseous fluid and to make use of gaseous neutralizing agents, such as ammonia or methylamine. Also, I may employ liquid bases having sufficient vapor pressure to remain volatile at the concentrations employed. As a rule, such neutralizing agents are best diluted by an inert gas, such as air, nitrogen, or the like.

I may also employ water-soluble alkaline materials and use an aqueous solution thereof for injection into the sewer. In such instances, the injection nozzles are best arranged to spray directly on the wall surfaces which it is desired to protect or to produce a finely-dispersed fog or mist which will drift to and collect on the exposed surfaces.

In the instance of a new sewer or other structure in which formation of corrosive acids has not yet taken place on the exposed surfaces, the alkalinization of the surface may be unnecessary, in which case it may suffice merely to neutralize or absorb the hydrogen sulphide present in the atmosphere. Under these circumstances, a spray of alkaline liquid may be employed without the requirement that it impinge on the surfaces which it is desired to protect.

Various types of nozzles or orifices may be employed and their disposition may be other than that illustrated in Fig. 1. For example, upwardly or laterally projecting nozzles may be employed instead of the downwardly depending nozzles as shown in Fig. 1, or the structure shown may be re-oriented by axial rotation relative to the union couplings. Also, the supply pipe 15 may be positioned at various points within the sewer, or

in the walls of the sewer, and in some instances may be laid external to the sewer with outlets running into the interior of the sewer.

Frequently a portion of the sewer will be subject to more severe corrosion than other portions and, in the vicinity of such a point, I may provide either a closer spacing of nozzles or employ nozzles of larger orifice, or both, to insure an adequate supply of a neutralizing agent in such a region of severe corrosion.

Where very extended lengths of pipe are employed, it is also frequently desirable to decrease the spacing interval or to increase the size of the orifice, or both, toward the down-stream end of the pipe in order to counteract the effects of pressure reduction attendant the passage of fluid through an extended length of pipe.

Where a very extended installation is contemplated, it may be some times advisable to provide duplicate installations for successive lengths of sewer. Each installation, however, will normally be able to protect several miles of sewer. In one typical design, a three-mile length of ten foot sewer is protected by a single run of pipe tapering from a diameter of 2" where the air and ammonia enter and to a diameter of ½" at the far end. Outlets and nozzles are spaced at 20 foot intervals, and an admixture of air and ammonia is supplied the pipe at a pressure of about 1 lb./sq. inch, the rate of air flow being about 8 cubic feet per minute, and the rate of ammonia flow being about 2 cubic feet per minute.

In some instances it is necessary to protect only individual points in the sewer. For example, the problem of corrosion may be encountered only in the vicinity of a manhole in which structures are present causing agitation of the flowing sewage with attendant localized evolution of undesirable quantities of hydrogen sulphide leading to the atmospheric corrosion described above. In such an instance, adequate protection may frequently be had by injecting gaseous ammonia solely at the point of localized evolution of hydrogen sulphide. A similar situation frequently obtains in sewage pump stations. In such situations, the means for applying the ammonia will be substantially simpler than that described above and need not comprise more than a tank of anhydrous ammonia, a control valve through which the ammonia can be allowed to escape slowly, and a tubing adapted to conduct the stream of ammonia to a suitable place of release in the vicinity of the structure subject to such localized corrosion.

In instances where the sewer is ventilated by a forced draft of air, the length of sewer swept by such a draft may be protected by the addition of an alkaline gas, such as ammonia, to the air entering the sewer.

In some instances, periodic, as contrasted with continuous, injection of the ammonia may suffice to prevent acids accumulating on exposed surfaces from reaching a dangerous concentration. For example, the ammonia may be released in quantities sufficient to insure neutralization of the exposed surfaces at hourly or daily intervals, depending upon the specific conditions present.

While I have described my invention with particular respect to conditions obtaining in sewers, it will be obvious that the methods and equipment employed may be used with equal efficacy in pipe galleries, tunnels, enclosed passageways, and in similar structures in which an acidic corrosive atmosphere may be present. For example, serious corrosion of lead cables carrying electric wires is often noted when the lead sheath of such cables is exposed to the atmosphere of tunnels in which such cables may be laid. Such corrosion has been variously attributed to the action of carbon dioxide and to the action of oxides of nitrogen produced by bacterial action. In any case, the corrosive agent is essentially acidic, and may be readily neutralized by practise of the present invention to give adequate protection of the lead cables and similar exposes surfaces.

I claim as my invention:

1. A method of preventing acidic corrosion of surfaces in sewers and which surfaces are exposed to the gaseous atmosphere above a stream of sewage flowing in said sewer, without treatment of the bulk of said sewage to reduce the sulphide content thereof, which method includes the steps of: introducing into said gaseous atmosphere a gaseous neutralizing agent capable of reacting with sulphuric acid tending to form on said surfaces exposed to said gaseous atmosphere; and controlling the amount of said gaseous neutralizing agent thus introduced to supply sufficient of said gaseous neutralizing agent to substantially neutralize the sulphuric acid tending to form on said surfaces during continued flow of said sewage along said sewer.

2. A method of preventing corrosion of surfaces in sewers and which surfaces are exposed to the gaseous atmosphere above a stream of sewage flowing in said sewer, without treatment of the bulk of said sewage to reduce the sulphide content thereof to such an extent as to prevent the appearance of sulphuric acid on said surfaces, which method includes the steps of: introducing into said gaseous atmosphere at a plurality of positions spaced along a length of said sewer a gaseous neutralizing agent capable of reacting with sulphuric acid tending to form on said surfaces exposed to said gaseous atmosphere, the total amount of said gaseous neutralizing agent being sufficient to neutralize said sulphuric acid forming on said surfaces in said length of said sewer during flow of said sewage therethrough.

3. A method as defined in claim 2, in which said gaseous neutralizing agent comprises gaseous ammonia and air.

4. A method of preventing corrosion of surfaces in sewers and which surfaces comprise concrete and are exposed to the gaseous atmosphere above a stream of sewage flowing in said sewer, said sewage being substantially non-acidic but acting to give off hydrogen sulphide during its flow along said sewer, said hydrogen sulphide being oxidized on said surfaces to produce sulphuric acid, which method includes the steps of: introducing into said gaseous atmosphere of said sewer at one position an amount of gaseous ammonia sufficient to neutralize the sulphuric acid tending to form on said surfaces in a zone adjacent said one position; and introducing into said gaseous atmosphere at another position downstream from said one position an amount of gaseous ammonia sufficient to neutralize the sulphuric acid tending to form on said surfaces in a zone adjacent said other position, said positions being sufficiently close to each other so that said zones will overlap to produce substantially complete neutralization of the sulphuric acid tending to form on said surfaces between said positions.

5. A method of preventing corrosion of surfaces in sewers and which surfaces are exposed to the gaseous atmosphere above a stream of sewage flowing in said sewer, said sewage acting to give off hydrogen sulphide during its flow along

said sewer, said hydrogen sulphide being oxidized on said surfaces to produce sulphuric acid, the amount of said hydrogen sulphide evolution increasing with an increase in turbulence of said flowing sewage, said sewage flowing more turbulently at one position than at another, which method includes the steps of: protecting said surfaces in the vicinity of said position of greater turbulence from the increased corrosion resulting from the increased hydrogen sulphide evolution and increased formation of said sulphuric acid on said surfaces by introducing gaseous ammonia into said gaseous atmosphere adjacent said position, the amount and rate of introduction of said gaseous ammonia being correlated with the rate of sulphuric acid formation on said surfaces in said vicinity to supply several times the amount of gaseous ammonia required to neutralize the sulphuric acid formed on said surfaces in said vicinity of said position.

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