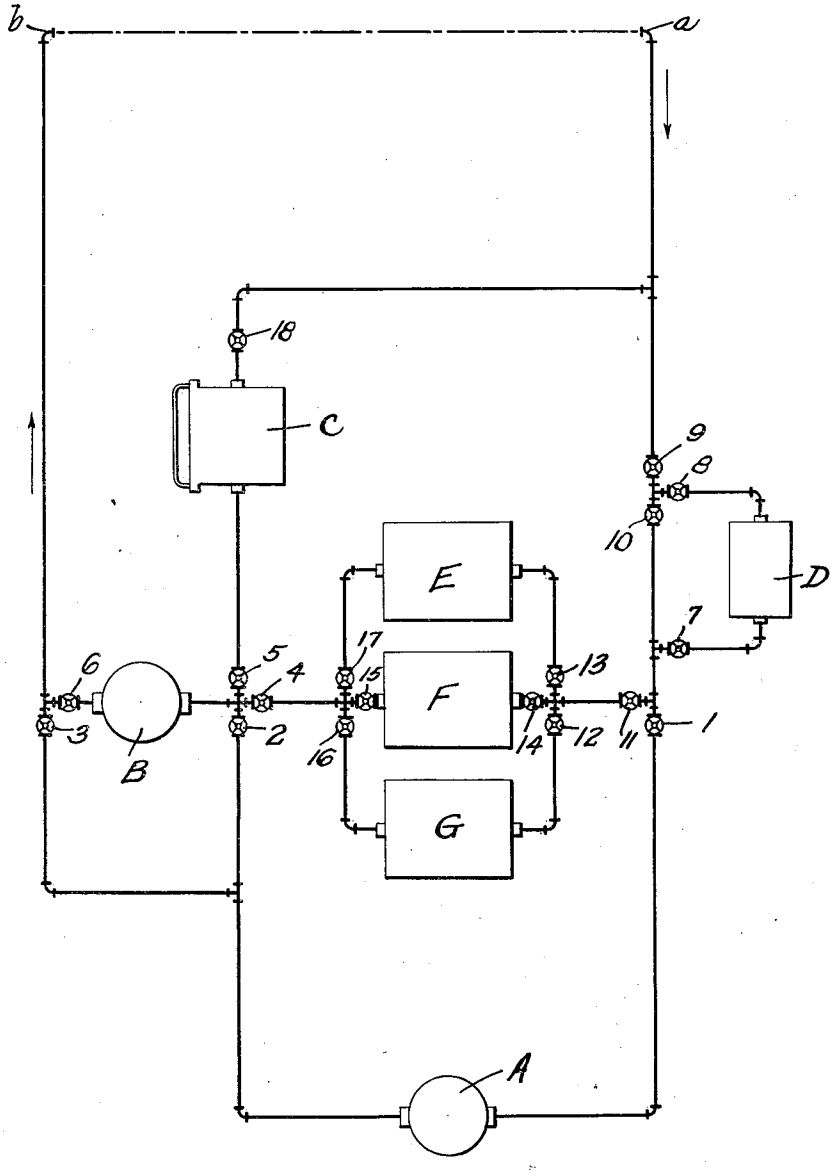
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METHOD OF REMOVING RUST, SCALE, AND SEDIMENT FROM THE INTERIOR OF METAL SURFACES

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METHOD OF REMOVING RUST, SCALE, AND SEDIMENT FROM THE INTERIOR OF METAL SURFACES

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My invention relates to an improved method of removing rust and scale from pipes, and the object of the invention is to provide a simple, effective and economical method for the purpose.

The invention has been especially designed for, and so far has formed its principal field of usefulness in the removal of rust and scale from water systems of buildings and particularly such systems in large apartment houses where the presence of such foreign deposits may be a serious economical detriment. The invention, however, is not limited to such use and it may be effectively employed in almost any connection where it may be desirable to remove rust and scale from pipes or piping systems, as for example, railroad steam generating plants on locomotives, water and heating systems of buildings, marine heating and steam generating systems, cooling systems for gas engines, etc.

I will describe the improved method as it will be carried out in removing rust and scale from the pipes of a hot water heating system of a large apartment house. The adaptability of the method for the removal of rust and scale in other connections will be immediately apparent therefrom.

To carry the method into effect, a suitable apparatus is necessary. This apparatus may differ widely in construction and arrangement, but in the accompanying drawing forming part hereof, I show in diagram an apparatus with which I have secured excellent results for the particular purpose referred to.

This apparatus is mounted upon a suitable truck which is moved as close to the building as possible, and from which flexible piping leads to the heating system to be cleaned whereby solutions, water and air may be forced through the entire heating system, in reverse directions, as will be pointed out hereafter.

The apparatus comprises an air compressor A of any suitable type, capable of developing a pressure sufficiently high to overcome the hydrostatic head of water in the heating system. The arrangement is such that the compressed air can be forced in either direction through the heating system. Valves 1, 2 and 3 cut off the air compressor A from the rest of the apparatus.

The apparatus next comprises a pump or series of pumps B of any suitable type, capable of developing a pressure in excess of that necessary to force water or solutions used throughout the heating system in either direction. The air compressor A and pump B may be conveniently driven by electric motors or gasoline engines. Valves 4, 5 and 6 permit the pump B to be connected to or disconnected from the heating system to be cleaned.

Next, the apparatus comprises a testing tank C into which the solutions can be run during the operation for the purpose of chemical or volumetric determination, as will be explained later.

The apparatus next comprises a filter D of any suitable type, by which the rust and scale may be removed from the circulating liquid. Valves 7, 8, 9 and 10 permit the filter to be connected to or disconnected from the rest of the apparatus.

Next, the apparatus comprises the tanks E, F and G, the purpose of which will be explained later. Valves 11, 12, 13, 14, 15, 16 and 17 permit all or any of the tanks to be connected to the rest of the apparatus or disconnected therefrom.

A valve 18 in conjunction with valve 5, permits the testing tank C to be connected or disconnected. The testing tank C, filter D and tanks E, F and G are all subjected to pressure and therefore, are closed.

The apparatus finally comprises suitable piping, as shown, connecting the several elements of the apparatus and in which the valves referred to are located. The two terminals of this piping are indicated at *a* and *b* and the dotted line extending between these terminals represents the heating system to be cleaned as well as flexible hose leading thereto from the apparatus on the truck.

With an apparatus such as I have described, I now proceed to carry out my improved method, as follows:

The first step is to fully drain off the water from the piping system, after having

closed off the street main or other source of supply. Clean water from tank G is now introduced into the piping system so as to entirely fill the same by action of pump B. This water is then drained off and measured by volume, in order that a comparison may be later made of the cubical capacity of the piping system, both before and after cleaning. Air is now forced into the empty piping system, all valves and outlets therein being tightly closed. This air pressure is of substantial value, for instance, a static pressure of fifty (50) pounds per square inch. The compressed air in the system will disclose the presence of any leaks or faults therein. Repairs of such leaks if thus disclosed, should be made before the operation progresses.

If the pressure is held in the piping system, showing absence of leaks, lead *a* is now opened and the air is then allowed to rush through the piping in the building through vent *a* in spurts. The direction of the air is then reversed and vent *b* is used in the same way. The air, escaping through these two openings in the piping system, acts to scavenge the interior of the pipes, removes some of the rust and scale and loosens and renders less tenacious some of the remaining rust and scale. Moreover, this air scavenging of the pipes, effectively carries off water, which if present would dilute and render less effective the solution used in the next step.

Solution A (hereafter more particularly defined) is now circulated through the system from tank E by means of pump B, being forced first in one direction and then in the other. During this circulation of solution A, compressed air from compressor A is allowed to enter the system so as to agitate the liquid therein, as I find that by so doing the effect of the solution in detaching and removing the rust and scale is enhanced.

Solution A, carrying with it the rust and scale in the form of a muddy sludge, passes through the filter or settling tank D, by which the solid material is removed. During this operation, solution A passes from and returns to the tank E as a closed system. From time to time the flow is diverted to the testing tank C, from which samples may be taken to indicate whether the cleaning has progressed sufficiently.

The treatment described is continued sufficiently long as to remove a large part of the scale from the interior of the pipe. It is not desirable to remove all of the scale, because the latter forms in more or less minute pits on the pipe walls and to remove these pits would tend to weaken the walls of the pipe and possibly cause leaks. I find as a matter of experience, that the nearer the cleaning operation progresses to the pipe walls, the more difficult it is to remove the scale and the slower the operation. This control is, therefore, automatic in a sense, since the operator will be advised that cleaning has progressed sufficiently when the test samples show that the cleaning effect in a given time is very much reduced.

The treatment just referred to may occupy anywhere from one to eight hours, depending upon the degree of congestion of the piping system and upon the capacity thereof. Experience has shown that the horizontal pipes in the cellar of a building are in a worse condition than the rest of the system. These horizontal pipes are first examined, before operations are started, and the amount of scale and other impurities is noted. From this observation, the operator will soon learn about how long it will be necessary to operate with solution A to remove rust, scale and other impurities to the required extent, the test samples taken at tank C serving as an effective check. Of course, the removal of any portion of the scale is an improvement, but best results are secured by removing substantially all the scale except that portion which is immediately adjacent and adhering to the pipe walls.

Referring now to the characteristics of solution A, I have found that a liquid solution containing an acid of the type of phosphoric and acetic acid, under the conditions above described, will dislodge, loosen and dissolve the rust and scale to a surprising extent, thus permitting the pipes to be effectively cleaned in a very economical way. Such acids have very little corrosive effect on the metal of the pipes, but at the same time I prefer to add to the solution an inhibitor, hereinafter discussed, by which any corrosive action is prevented, and the cleaning effect of the acid solution is enhanced. An example, of a solution A with which I have secured excellent results is:

	Per cent
Phosphoric acid	40
Acetic acid	10
Butanol (secondary)	30
Alcohol (C. D. No. 1)	20

After the piping system has been treated with solution A as above explained, the solution is drained off from the cleaned pipes, and solution B from tank F is then circulated back and forth in the same way. In practice I have used for solution B, a one per cent. (1%) solution of butyric acid, although a one per cent. (1%) solution of acetic acid may be employed in which case it is desirable to substitute butyric acid for the acetic acid in solution A. The effect of using a weak acid solution in this way, is to diminish the acid effect due to solution A on the walls of the pipes. In this way, and in a comparatively short time, all traces of acid are removed from the piping system or at least, to such an extent that flushing out the system with clear water from tank G will have that

effect. After all traces of acid have been removed in this way, the system is drained and is then filled with clear water, which is accurately measured. A comparison between the respective volumes representing the cubical contents before and after treatment will indicate the amount of rust and scale removed and indicate to the operator the extent and completeness of the cleaning. This completes the method and the system is now ready for use after being filled with water in the usual way.

Referring now to the subject of inhibitors, I find that phosphoric, acetic and butyric acids all tend, in a small degree, to corrode the iron of the piping at the same time that the oxide sludge is attacked. It is important that this oxidation should be avoided and to this end I prefer to add a trace of an inhibitor to solutions A and B. The exact reaction of the inhibitor, I am not yet able to explain. Some have been found to go into solution with the acid, others to combine with the iron oxide and still others to act as catalysers. Their effect, however, with my improved method is very definite; that is to say, they practically neutralize any oxidizing action of the acids used and at the same time increase the action of those acids in removing rust and scale. These inhibitors are usually of an organic nature, although some inorganic substances may be employed, such as arsenic compounds, cyanamid, formaldehyde, sulphuric acid and lead. Some of the organic catalysers which may be used are glue, nicotine, ethyl alcohol, quinolin, butanol (normal, secondary or tertiary), pyridine and paraethylaminophenyl.

With solution A I have secured excellent results with both quinoline and pyridine in minute quantity—a fraction of one per cent. The same inhibitors may be used with solution B, and, as an example, I have found that a small amount of a very weak solution of glue satisfactorily answers the purpose. Such a solution may be made by dissolving one quart of glue to one hundred gallons of water.

In the foregoing, I have described my invention in the form preferred by me, but it will be, of course, understood that it may be modified in some particulars and according to the specific use to which it may be put. The extent of such modifications, is indicated in the appended claims.

What I claim is:

1. The method of removing rust and scale form a closed piping system in situ which consists in circulating therethrough and under pressure a solution of relatively weak acid having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

2. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of phosphoric acid having the capacity of attacking and removing rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

3. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of phosphoric acid and acetic acids having the capacity of attacking and removing the rust and scale, facilitated by the erosion of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

4. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of a relatively weak acid having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids, removed with and by such solution and in recirculating the filtered solution under pressure through the piping, the direction of flow of the circulating solution being periodically reversed.

5. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of a relatively weak acid having the capacity of attacking and removing rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution, in recirculating the refiltered solution under pressure through the piping and concurrently with such circulation in forcing compressed air through the solution in the piping.

6. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of a relatively weak acid having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, such solution also containing an inhibitor for preventing the solution from attacking the metal walls, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the refiltered solution under pressure through the piping.

7. The method of removing rust and scale from a closed piping system in situ which

consists in circulating therethrough and under pressure a solution of a relatively weak acid having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution, in recirculating the filtered solution under pressure through the piping, in removing the acid solution from the piping, and in circulating under pressure through the piping a slightly acid solution having an inhibitor added thereto to free the interior walls of traces of the first solution.

8. The method of removing rust and scale from a closed piping system in situ which consists in applying a static pressure of air to the closed system, in then releasing the air pressure while maintaining the flow of air through the piping to the atmosphere to blow out trapped water and effect the scavenging action, in circulating through the closed piping and under pressure a solution of a relatively weak acid having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

9. The method of removing rust and scale from a closed piping system in situ, which consists in circulating therethrough and under pressure a solution of phosphoric acid, acetic acid, and butanol, having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

10. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of phosphoric acid, acetic acid, butanol and alcohol having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

11. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution comprising approximately forty per cent phosphoric acid, ten per cent acetic acid, thirty per cent butanol and twenty per cent alcohol, said solution having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping.

12. The method of removing rust and scale from a closed piping system in situ which consists in circulating therethrough and under pressure a solution of a relatively weak acid having the capacity of attacking and removing the rust and scale, facilitated by the erosive action of the flowing solution, in filtering under pressure to separate the solids removed with and by such solution and in recirculating the filtered solution under pressure through the piping, the circulation of such solution being continued to the point where the encrusting material is almost but not wholly removed.

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