

COLWELLS, SHAW & WILLARD,



MANUFACTURERS OF

WILLARD & SHAW'S
PATENT TIN LINED
LEAD PIPE.



Patents Granted March 10th, 1863,
And January 26th, 1864.

Slater & Riley, Printers, 147 Fulton St. New York.

WILLARD & SHAW'S
IMPROVEMENTS
IN THE
CONSTRUCTION OF PIPE,
FOR CONDUCTING
WATER AND LIQUIDS
FOR
DOMESTIC USE.

*Patents Granted March 10th, 1863, and
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NEW YORK:
SLATER & RILEY, PLAIN AND FANCY STEAM JOB PRINTERS,
No. 147 FULTON STREET.
1865.

FACTS

RESPECTING THE CHOICE OF PIPE FOR CONDUCTING WATER AND LIQUIDS FOR DOMESTIC USE.

Pipes for the conveyance of Water are made of *Wood, Iron, Copper, Stone, Pottery-Ware, Lead, Tin*, and recently of *Bituminized Paper*.

Wooden Pipes are the least expensive at first, but they want strength to resist pressure of fluids and are liable to decomposition, decay, leakage, and infection of insects. And water lying long in wooden pipes becomes putrid from the animal and vegetable matter collected in them.

Cast Iron Pipes are superior for durability and strength, and are now universally employed as "Main Pipes" for conducting water. An idea has sometimes been entertained that the iron is injurious to the salubrity of the water: but a thin black oxide soon forms upon the inside of the pipe, and defends it from the action of the water, "forming a sort of black japan."

Copper Pipes are never employed, except in particular cases, in machinery and apparatus of various kinds.

Stone Pipes have been used; and are perfectly safe and wholesome; but difficult to execute, and therefore too expensive.

Pottery-Ware Pipes can only be made in short lengths, and are very liable to be broken, and can never be made to bear much pressure. It appears from some ancient buildings, that the Romans sometimes made use of them.

Tin Pipe is employed for beer, "soda water," condensing worms of stills in the chemist's and pharmacist's laboratories, and occasionally for service pipe in dwelling-houses.

Lead Pipe is commonly used for conducting water from the iron "main pipes," under the streets, into and through buildings. The physical qualities of this pipe admirably adapt it for such use; and in this regard nothing better could be desired. It is easily bent, soldered, and repaired when damaged by accident; and when subjected to pressure, or strain, or in case of the water freezing, it yields sufficiently to save it when either of the other pipes mentioned would split or break. These properties have influenced its adoption, notwithstanding a risk popularly understood and admitted, of injurious results to the health of those employing it.

Tin-Lined Lead Pipe.—Inventors and manufacturers of the United States, Great Britain and Europe, have given much labor, during fifty years, to experi-

ments for making a pipe which would possess the physical qualities of lead, and, at the same time, the chemical properties of tin. These gentlemen have been stimulated in their efforts by the universal advice of chemists and physicians respecting the want and value of such a pipe. As the records of inventions will show, there have been many plans proposed to attain the object desired. One of these consisted in coating ordinary lead pipe inside and outside with tin, by drawing it through a bath of the molten metal. The inventor of this process succeeded in coating the lead with tin of about the thickness of that which covers the sheet-iron constituting the tin plate of commerce. And it was this pipe which was referred to by Dr. ROBERT CHRISTISON, in his *Treatise on Poisons*, at page 415, where, after considering the injurious effects liable to occur from the use of lead pipe for conducting water, he states as follows: "*I should add that an effectual remedy has been lately introduced by a patent invention for covering lead pipes both externally and internally with a thin coating of tin.*" This coating proved afterwards, however, to be not sufficiently perfect, nor thick, to attract the attention of the public to a degree required for any considerable introduction of the pipe thus treated into use; but it has been, and is still made to a limited extent.

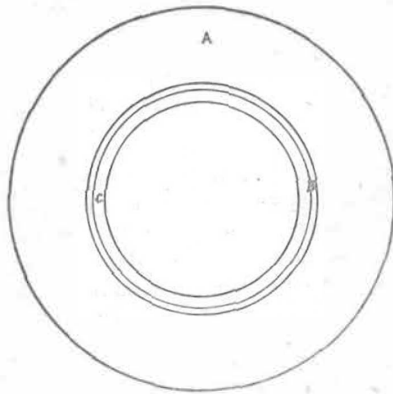
Lead pipe has also been electro-plated with tin; but this coating, though attained by a more complicated and expensive process, was really no improvement upon the one previously named. It was no thicker, and equally, if not more liable to be porous.

Short lengths of lead pipe lined with tin have been made by nicely fitting a hollow cylinder of tin within another of lead, and then "drawing" the two together by the old method of forming lead pipe. The frequent parting of the tin by this process, necessitated the cutting of the pipe into very short lengths; while no positive union and adhesion of the tin to the lead took place.

Several other plans have been tried, and more or less practiced; but while some have been attended with such difficulties in the manufacturing as to make the pipe expensive, all have been comparatively imperfect; and, consequently, not of a character necessary to attract the attention required for bringing either of them into considerable use.

MESSRS. COLWELLS, SHAW & WILLARD, of New York, have recently completed a very large factory and improved machinery, to be employed exclusively in manufacturing a Tin Lined Lead Pipe, for which patents have been secured by WILLARD & SHAW. The pipe manufactured by these improvements differs in several respects from any other of its kind. The lining of tin is made of any reasonable thickness desired, perfectly uniform throughout the whole length of the pipe, and coils of any required number of feet. One peculiar and valuable feature of this pipe is that of a perfectly uniform stratum of an alloy of tin with lead which is formed between the tin constituting the lining of the pipe and the lead outer pipe. This causes the whole pipe to comport itself as a homogeneous metal during its construction not only, but also when applied to the various uses for which it is designed. Following is a drawing of the end of the pipe, exaggerated in proportions somewhat, for the purpose of showing the perfect union of the tin with the lead by the intervening alloy.

A represents the Lead Pipe ; C the Block Tin ; B an Alloy of Tin with Lead, intervening and firmly joining the inner and outer pipes.



This pipe has sufficient pliability and other qualities required by plumbers. And its strength to resist strain, and sustain pressure, are ample, and the chemical properties of its lining sufficiently satisfactory to warrant the recommendation of it for general use.

The following drawings afford an idea of the character of this pipe. The figures are of the exact thickness and proportions, in all particulars, of the samples referred to in the statement of BENJAMIN S. CHURCH, Esq. which is added.

Tested by Hydraulic Pressure to a bursting strain, illustrating their comparative strength.

Fig. 1

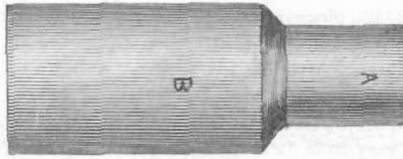
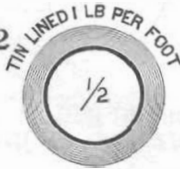


Fig. 2



Burst at 1650 lbs. Pressure sq. inch.

Fig. 3



Burst at 1200 lbs. Pressure sq. inch.

Fig. 4



Burst at 1325 Pressure sq. inch.

Fig. 5



Burst at 1150 lbs. Pressure sq. inch.

Figure 1 represents a specimen of Tin Lined Pipe, with a portion of the lead or outer pipe (B) removed, so as to show the tin or inside pipe (A).

Figures 2, 3, 4 and 5 are Sections of Tin Lined and Lead Pipe, tested by Hy-

draulic Pressure, referred to in accompanying Report, from the Croton Aqueduct Department.

The Heavy Line, on the inside of Figures 2 and 4, represents the Tin as enclosed by the Lead.

CROTON AQUEDUCT DEPARTMENT,
ENGINEER'S OFFICE,

May 12th, 1864.

MESSRS. WILLARD & SHAW:

Dear Sirs—It gives me pleasure to express my satisfaction at the result of the experiments which I had the pleasure of witnessing on Saturday last, in which you completely demonstrated the *superior strength* of your "Tin Lined Lead Pipe" over the ordinary lead pipe, the weight of which was from 75 to 100 per cent. greater. These experiments proved the bursting pressure of the half-inch Tinned Pipe to vary from 1200 to 1650 pounds, while the half-inch Lead Pipe could bear but from 1100 to 1200 pounds per square inch, the tests on the larger pipe varying in about the same ratio.

You have succeeded in making so complete a union of the outside lead with the tin lining, that it is quite impossible for the moisture to get between to form destructive galvanic currents, so that, as far as I am able to judge, your invention answers every requirement.

Your most obedient servant,

[Signed]

BENJ. S. CHURCH,
Asst. Eng'r Croton Works.

From DUBOIS D. PARMELEE, M. D. *Practical and Analytical Chemist.*

NEW YORK, May 18th, 1864.

MESSRS. WILLARD & SHAW:

I have read the letter of BENJAMIN S. CHURCH, Esq. Assistant Engineer Croton Works, which bears date of the 12th inst. and relates to trials of the strength of your "Tin Lined Lead Pipe." I was present when the experiments to which he refers were made, and from reference to my own memoranda, I endorse his statements.

Yours respectfully,

[Signed]

DUBOIS D. PARMELEE.

From Professor ALEXANDER H. EVERETT, *Analytical and Consulting Chemist.*

NEW YORK, 20th May, 1864.

MESSRS. WILLARD & SHAW:

Gentlemen—Having been present at the experiments upon the strength of the "Tin Lined Lead Pipe," referred to by Mr. CHURCH, of the Croton Department, I have no hesitation in endorsing his statements to the fullest extent.

Yours very respectfully,

[Signed]

A. H. EVERETT.

These and similar experiments have been repeated by and in the presence of many parties whose testimony might be added if necessary.

It is true that lead pipe has been long and quite universally used for the conveyance of water from almost every variety of sources; but the necessity (as it may almost be said) for this custom has already been referred to in preceeding lines. The following is from DR. CHRISTISON'S *Treatise on Poisons*, p. 400. "The action of water on lead, which is of much greater consequence, has been made the subject of observation by the curious for many ages. The Roman architect Vitruvius, who, it is believed, flourished in the time of Cæsar and Augustus, forbids the use of this metal for conducting water, because cerusse, he says, is formed on it which is hurtful to the human body. Galen also condemns the use of lead pipes. * * * * If we trace the sciences of Architecture, Chemistry, and Medicine downward from these periods, nothing more will be found than a repetition of the statements of Vitruvius and Galen. * * * * The first person to examine the subject minutely, was Dr. LAMBE, of Warrick; who inferred from his researches, that most, if not all spring waters possess the power of corroding and dissolving lead to such an extent as to be rendered unfit for the use of man."

From THE CAVENDISH SOCIETY'S EDITION OF GMELIN'S CHEMISTRY, Vol. V.
Page 114.

"AQUEOUS SOLUTION OF LEAD-OXIDE.—Clean lead in contact with water and air free from carbonic acid, yields a solution of lead-oxide which turns reddened litmus blue, gives a faint red tint to tumeric, is turned brown by sulphuretted hydrogen, and gives white precipitates with sulphuric acid and with several salts. Water, freed from air by boiling, does not dissolve lead when kept in contact with it in a close vessel; water which has been agitated with air becomes charged with lead-oxide in the course of two hours, the quantity dissolved amounting to between $\frac{1}{12000}$ and $\frac{1}{10000}$: it then slightly reddens tumeric, and turns reddened litmus blue; becomes turbid when shaken up in a half-filled bottle, or when boiled; yields lead at the negative and peroxide at the positive pole when acted upon by the electric current; gives a brownish black precipitate with hydro-sulphuric acid; becomes turbid immediately with carbonic acid (the turbidity, however, disappearing when the acid is in excess), or with sulphuric acid, or acid sulphate of potash or soda; more slowly with the neutral sulphates; becomes turbid when mixed with sulphate of lime or common salt, and slowly with nitre; forms with iodide of potassium a white cloud, which turns yellow on the addition of a small quantity of very dilute hydrochloric acid, together with a yellow precipitate; with chromate of potash, it forms a yellow precipitate on the addition of acetic acid. Spring water of tolerable purity, two pounds of which contain only $1\frac{1}{2}$ grains of salts and no carbonic acid, likewise, when passed through a leaden tube 150 feet long, dissolves a quantity of lead sufficient to give a brown color with hydro-sulphuric acid."

Distilled water in contact with lead and with air free from carbonic acid, dissolves $\frac{1}{70000}$ lead oxide, acquires an alkaline reaction, and becomes turbid on ex-

posure to the air in consequence of the formation of hydrated bicarbonate of lead oxide. Wetzlar found that aerated water, after being placed in contact with lead, gave a very slight precipitate with hydro-sulphuric acid, but no alkaline reaction. The presence of small quantities of carbonic acid, sulphuric acid, or of various salts, prevents the solution of the lead-oxide, or greatly diminishes the quantity dissolved: this was first observed by Morveau—1 volume of water charged with two-thirds vol. carbonic acid gas dissolves a mere trace of lead-oxide in the form of carbonate, which may be detected by hydro-sulphuric acid, and the lead remains quite bright; this water, after boiling, again exerts a solvent action if exposed to the air. Spring water, 10 pounds of which contain 1.21 gr. chloride of sodium and chloride of calcium, together with 64. gr. carbonate of lime dissolved in excess of carbonic acid, produces a slight deposit of brownish oxide on the surface of the lead, but does not dissolve any. (Yorke.) When lead is immersed in water containing sulphate of potash, common salt, or nitre, and exposed to the air, the water takes up a mere trace of lead-oxide, recognizable by hydro-sulphuric acid. (Wetzlar.) The greater the purity of spring water, the greater the quantity of lead which it dissolves, and the less fit are leaden pipes for conducting it. *Leaden pipes should not be used for the purpose unless lead remains untarnished after twenty-four hours' immersion in the water; they are unfit for conducting water containing less than 8000 of its weight of salts. If the quantity of salts exceeds this limit, and the salts consist mainly of sulphates and carbonates, leaden pipes may be used; but if they consist chiefly of chlorides, even one part in 4000 is not sufficient to prevent the solution of the lead.* (Christison, Phil. Mag. J. 21, 158.)

From BRANDE and TAYLOR'S Chemistry, p. 397.

"There are very few waters which have passed through leaden pipes in which a minute analysis will not detect a trace of the metal; and were it not for the great convenience of lead, iron pipes would, in a sanitary point of view, be in all cases preferable."

The following was written by PROF. JAMES C. BOOTH, U. S. Mint, Philadelphia, for Encyclopedia of Chemistry, p. 756.

"A spring water conducted through 8000 feet of lead pipe into a cistern, became so charged with lead as to affect the health of a family, and upon testing it, I found in it a notable quantity of lead. After charging the pipe with a solution of Glauber's salt, and then passing water through it, the latter yielded, after concentration of 200 to 1, scarcely a trace of a dark precipitate, which was

only sufficient to prove by the blow-pipe that it was copper and lead, or tin. As it is usually necessary to concentrate water to test for the presence of lead, an error must be guarded against, which has been too often neglected, viz: the loss of the greater part of the lead-salt in solution, carried off in the vapor of water. Some preliminary experiments on this point, by Mr. C. HARTSHORNE and myself, proved, that if a salt of lead dissolved in a very large amount of water, and then evaporated, be compared with another, in which so much of the salt was dissolved as ought to be contained in the former concentrated liquid, the difference in the effect of sulphuretted hydrogen is very striking; for while it gives a decided precipitate in the latter, it either produces none in the concentrated liquid, or at most, an indistinct, yellowish coloring. We found that the nature of the salt had an influence on its volatility."

The following are selected from the preface written and arranged by JAMES P. KIRKWOOD, Esq. C. E. for Collections of Reports and Opinions of Chemists in regard to the Use of Lead Pipe for Service Pipe, etc. The writer says: "They have been somewhat condensed, but the omissions are not of a character to alter the general sense, or to convey a mistaken impression of the conclusions of their several writers."

Professor WILLIAM THOMAS BRANDE, London.

"Water by itself, without carbonic acid, will not hold in solution more than two grains of lime to a gallon; two grains of carbonate of lime and hardly that; the addition is held in solution by the carbonic acid."

"Many of these waters (Farnham and Watford waters, soft), have a very considerable action upon lead, to an extent, I should think, to be very dangerous; much more so than either the Thames or the Lea water."

3d June, 1843. DR. THOMAS CLARKE, *Professor of Chemistry, Aberdeen University.*

"It is well known that distilled water acts very readily upon lead. The cause of this action I apprehend to be the remarkable power that distilled water, compared with ordinary water, has of dissolving free carbonic acid. In general an alkaline water will not act upon lead or upon iron. But, perhaps, I should not say, in general, for I have examined a sufficient number of cases to lay down a general rule. . . . With respect to lead pipes, I should say, the less lead is used the better in all cases. . . . It is desirable to use it [lead] as little as possible; not that it is in all cases objectionable, far from it."

28th March, 1844. JOSEPH QUICK, *Engineer of Southwark Water Company.*

"At Clapham Common the manor estate was supplied with water from a spring well in the centre of the Common, through the lead pipes, and the inhabitants were attacked with severe illness, which was ascribed to the length of lead pipes through which the water passed. Lead was detected in the water upon analysis, and the lead pipes were taken up and iron pipes substituted."

ANGUS SMITH, M. D. of *Manchester.* 1850.

"It is acknowledged, that with soft water, lead is very dangerous, but I am disposed to think that it is dangerous even with hard, except when a crust forms upon it. It is time that the use of lead pipes and cisterns should be done away with, unless *they can* be protected."

WILLIAM MELHUISCH, *Plumber, London.*

"Have you observed that all Thames water acts upon lead cisterns? Yes; but in some old cisterns of two hundred years of age, and which are made of very thick lead, the water has only eaten half through them, while in modern cisterns the water has eaten quite through the lead. . . . Rain water never acts upon the lead; I never knew a rain water cistern that was destroyed."

WILLIAM HAWKINS, *Plumber, London.*

"Then, as the general result of your observation and experience, you would say that hard water acts upon lead in a greater degree than soft water? That is just what I have always observed."

DR. SHIER, *Agricultural Chemist to the Colony of Demerara.*

"My attention was first called to the subject by Dr. BLAIR, our Colonial Surgeon General, in consequence of symptoms of lead poisoning occurring in his

practice. On investigation I found lead in the suspected water, and in quantity too large to admit of a doubt of its being the cause of great and wide spread mischief."

HENRY M. WARD, *Lecturer on Chemistry in St. Guy's Hospital.*

"I am inclined to think that the action on lead depends greatly on the aeration of the water. In rainy weather, when the Doe water is colored and contains little air, the quantity of lead dissolved in any case appears to be less than when the water is clear and well aerated.

DR. W. A. MILLER, *of London, Professor of Chemistry.*

"It is a fact, but too well attested by experience, that numerous instances of poisoning have been traced to the employment of water which has become impregnated with lead from leaden service pipes or cisterns. There are two modes in which water may act on lead: 1st, It may corrode the metal and form a white deposit evident to the eye; 2d, It may dissolve the metal, in which case the employment of proper tests would be necessary to render the fact apparent."

"The proportion of lead required to produce serious ill effects in a case where Mr. HERAPATH analyzed the water, was found to be less than one-ninth (1-9) of a grain per gallon."

DR. GEO. WILSON, *Lecturer on Chemistry, Edinburgh.*

LOCH KATRINE WATER.

"The entire amount of lead present in the water (experimented on in lead pipes), both in the soluble form, amounted to 1.58 grain in one case, and in another to 2 grains per gallon. The amount held in solution, after filtration through paper, averaged from 1.9th to 1.6th grain per gallon. A water which acts thus cannot possibly be conveyed through lead pipes with safety to the health of those doomed to drink it."

WILLIAM WALLACE, *Analytical Chemist, Glasgow.*

"It is my opinion that Loch Katrine water (a very soft water), could not be introduced through lead pipes, or retained in lead cisterns, with safety to the inhabitants."

ROBERT DUNDAS THOMPSON, M. D. *Professor of Chemistry, London.*

"Although in the preceding report I have given it as my decided opinion that no more permanent danger is to be apprehended, in reference to health, from the transmission of Loch Katrine water through lead pipes and detention in lead cisterns, than there is in the case of other waters supplied to towns, I have always recommended the substitution of iron and other materials for water pipes, as much as possible, for lead, and also where lead is employed, that it should be alloyed with tin."

B. SILLIMAN, JR. *Analytical Chemist, New Haven.*

QUEBEC WATERS.

"We confidently state, therefore, the important fact, that the passage of water through iron pipes, prepares it for a more speedy and certain action on lead. . . . It must be admitted, however, that as far as our present knowledge of facts goes, the cases of poisoning with lead, in New York, have been rare exceptions, but the public attention has as yet not been fully awakened to the subject."

HORATIO ADAMS, M. D. *Waltham, Mass.*

"It is never safe to use water drawn through lead pipes, or stored in leaden cisterns for domestic purposes, and that any article of food or drink is dangerous to health, which, by any possibility, can be impregnated with saturnine matter."

Report of the GENERAL BOARD OF HEALTH, on Supply of Water to the Metropolis, London. May, 1850.

"The use of lead pipes should be discontinued as early as practicable. As a question of danger, however, a preponderance of testimony establishes the conclusion, that hard water, with an intermittent supply, is actually more dangerous than soft water with a constant supply."

Report of CROTON AQUEDUCT BOARD. December, 1849.

"The Department is aware of but a single case in which any precautions can be necessary in the use of Croton water for drinking, and these only at elevations where the supply is not constant. In the upper stories of buildings, where the pipes are alternately wet and dry, caused by the daily variations of head, it is possible that the interior of the pipes, by the united action of air and water, may be so oxydized, as that particles of carbonate of lead might be carried off, held in suspension by the water, and received in the stomach by drinking it; it would be imprudent, therefore, habitually to drink water from taps so circumstanced."

SAMUEL L. DANA, M. D. Chemist. Report on Lowell Water.

"The fact so well known to our citizens that leaden pipes are corroded and destroyed by well water, would long ago have told them the effects of using such water, were it not that the disorders produced by it are of such slow and insidious character, that they have been attributed to other sources. That lead in continued small doses is a cause of disease and death, is the accumulated testimony of two thousand years."

DR. C. J. JACKSON, Assayer to the State of Massachusetts. June, 1852.

"I have long since been convinced that it is unsafe to use lead for conducting water by aqueducts."

TANQUEREL DES PLANCHES on Lead Diseases. Dana's Translation.

"DR. WALL has seen all the residents on a farm attacked with lead colic, from drinking water from a pump the cistern of which and the pipe were lined with lead. It is partly through pipes of lead that water is distributed in public and private establishments in Paris; and Tanquerel has never learned that water thus conveyed has caused lead colic there. The inhabitants of some cities, establishing fountains, have suffered with colic from using the water which first passed through the new pipes."

MURPRATT'S Chemistry applied to the Arts : Lead.

"The first stage of slow poisonings are very frequent, and well known to most of the general medical practitioners in every large town. The source is almost invariably found to be the water employed for domestic purposes. Several cases of this kind have come under the notice of the editor, wherein whole families were affected. Iron glazed pipes and pumps, with slate or cemented cisterns, were recommended for adoption, and with very marked effect, the health of the individuals being completely restored. So small a quantity as three or four grains of a sulphate or a phosphate in water prevents, after some time, the corrosion of the metal. It must, however, be remarked, that these salts do not protect the lead from the solvent action of waters which contain nitric or nitrous acids in solution. These two acids are products of the decomposition of animal matter, and any water containing them will infallibly act upon lead; and consequently it would be highly dangerous to pass such a water through leaden pipes or to store it in leaden cisterns."

From a Report of DR. CHILTON.

"In several instances I have detected lead in the water which have stood in lead pipes over night, in situations where free use was made of the water during the day. I have also made a series of experiments to determine the action of Croton Water upon pipes made of pure lead, and also of those made of lead coated with tin. The results proved that the water that passed through the lead pipe always contained lead, while that from the pipe coated with tin did not contain a particle of lead. The internal use of water containing lead is highly injurious, and manifests itself by tremulousness and general debility of the nervous system."

JAMES R. CHILTON, M. D.

Some years since, the late Dr. JAMES R. CHILTON investigated the subject of Lead Pipe, and came to conclusions very unfavorable to the use of that article.

He remarked that "Numerous Chronic Diseases and Deaths are unquestionably owing to solutions of lead, insidiously received into the stomach by the use of water, ale, cider, &c. conveyed through leaden pipes."

His opinions were endorsed by most of the scientific men of the day, including which were the following eminent names, viz. :

JOHN TORREY, M. D.	<i>Professor of Chemistry.</i>
JAMES RENWICK,	" "
WM. H. ELLETT, M. D.	" "
WM. JAMES MAC FEVER, M. D.	" "
JOHN B. BECK, M. D.	<i>Professor Materia Med.</i>
LEWIS B. BECK, M. D.	<i>Professor Chemistry.</i>
ALEX. H. STEVENS, M. D.	<i>Professor Surgery.</i>
L. P. GALE, M. D.	<i>Professor Chemistry.</i>
J. SMITH ROGERS, M. D.	" "
EDWARD DELAFIELD, M. D.	" <i>Obst.</i>
JOHN STEARNS, M. D.	
DAVID HOSACK, M. D.	
JOHN W. FRANCIS, M. D.	
J. KEARNEY ROGERS, M. D.	
JOHN NEILSON, M. D.	
JOHN C. OHEESEMAN, M. D.	
ALEX. E. HOSACK, M. D.	
EDWD. G. LUDLOW, M. D.	
RICHD. R. HOFFMAN, M. D.	
WM. F. HOPKINS,	<i>Professor Chemistry.</i>
B. SILLIMAN,	" "

Extract from Letter of SAMUEL L. DANA, M. D. L.L. D. published in his work on "Lead Diseases."

"I was requested by a medical friend to examine some Croton Water, drawn directly from the street main, through a leaden pipe, into the house for family use. Disorder, supposed to arise from lead, had appeared in more than one member of the family. It was this which caused a chemical examination to be requested. The result of my examination showed lead in solution, with the following classes of salts, per gallon :

" Alkaline chlorides, with crenic acid,	0.6149
" Alkaline sulphates and organic acids,	1.2298
" Lead oxide, silica, carbonate of lime, magnesia, alumina and apocrenic acid,	1.5373
	<u>3.3820</u>

"The water was discontinued, and the health of the patients restored. Here, then, we have direct proof of the solvent power of lake water on lead pipes. This is not a solitary instance," &c. * * * * "I presume that I need not

enter into any detail of the effects of lead water upon health. This whole question is based on the principle generally conceded, that it is a poison, producing grave diseases, ending often in death."

DR. GEO. H. KINGSBURY has published, in the *New York Journal of Medicine*, for May, 1851, four cases of obscure disease, fully attributable to the use of Croton Water drawn from lead pipes.

DR. KINGSBURY reports: "Since the introduction of Croton Water into the city, cases simulating lead colic have occasionally been met with; yet, in the absence of the usual and well-known causes of that disease, and the seeming improbability of a sufficient amount of lead poison being held in solution by Croton Water, from passing through lead pipes, the symptoms have usually been ascribed to other causes, or left altogether unaccounted for."

In two cases reported by DR. KINGSBURY the patients suffered repeated attacks of lead disease before the true cause was suspected, and removed, there was no return of disease.

We quote from a report of HORATIO ADAMS, M. D.:

"The next point your Committee will notice is the great difference in the length of the exposure of individuals to lead influence before disease is developed, varying from a few weeks to something more than nine years. This may, in part, be owing to the intensity or degree of strength of the poison introduced into the system. Extremely minute quantities may be taken for a great length of time before there will be sufficient accumulation to produce disease. The minuteness of the quantity of poison in water, which may in time produce disease, cannot be limited; less than 1-100 of a grain per gallon has been known to produce it."

DR. FENNER, in a letter, speaking of the diseases of New Orleans in 1851, says:

"I am decidedly of opinion that encephalopathy, arthralgia (*vulgo* rheumatism), neuralgia and paralysis, arising from lead poisoning, prevail in this city to a considerable extent."

DR. HAYES, of Lowell, at present of Boston, remarks:

"It has been supposed, from imperfect experiments, that waters containing certain small portions of salts do not act on lead. Some years have passed since the opinion favoring such a conclusion was published.

"The lapse of that time has permitted the accumulation of facts and observations which, placing the fallacy of such an opinion beyond doubt, have established the conclusion, that *all natural waters act on lead chemically, under the varying states of atmospheric changes.*

"Lead, as a material for pipes, cannot be safely used for conducting water which is to be used for domestic purposes."

DR. JACKSON, of Boston, and PROF. SILLIMAN, of New Haven, also confirm DR. HAYES' opinion, as well as DR. DANA, of Lowell.

Extract from a Report to the City Council of Lowell.

"The fact, so well known, that leaden pipes are corroded and destroyed by water, would long ago have told the effects of using such water were it not that the disorders produced by it are of such *slow and insidious* character that they have been *attributed to other sources*, till chemical analysis has pointed out a cause of disease more to be relied on than doubtful speculation.

"There is reason to believe that a vast many cases of rheumatic, and spasmodic, and nervous disease—a general breaking up, as it were, of the foundations of the great deep of life—have occurred, which can be attributed only to the *effects of small, daily doses of lead.*"

Remarks from JAMES P. KIRKWOOD, ESQ. C. E. and Editor of Reports, etc. in regard to the use of Lead Pipe for Service Pipe, etc.

"I have accidentally met with several marked instances of severe lead poisoning, traceable to the use of lead pipe, and I am satisfied that the only safe course in families is to avoid entirely the use of lead pipe for service pipe. Why run the risk when other kinds of pipe, not open to the same objections, can so readily be obtained?"

From a Letter of REV. DR. LAMSON, of Dedham, Mass.

"I can never feel more certain of any fact whatever than I was, and am still, that all my sufferings came from the use of water conveyed in lead pipes."

Report of SAMUEL R. PERCY, M. D. *Professor of Materia Medica, New York Medical College.*

At the request of Messrs. WILLARD & SHAW, I have made a thorough investigation of their Tinned Lead Pipe, and find it a most perfect article, as the tin forms a thick and complete protection over the lead. At their request I have also made a series of investigations to ascertain if the ordinary Lead Pipe, through which the Croton Water is supplied to our houses, contaminates the water which flows through it with lead. I find, when the Croton Water stands in the lead pipes for some hours, that by chemical analysis, the water always shows the presence of lead. In a house where the lead pipes had been down for twelve years, I found that if the water stood in the pipe for a single hour it would show the presence of lead; such water is very injurious to the health. Beer, lager beer, root beer, cider and soda water drawn through a lead pipe will always show the presence of lead, and frequently become exceedingly injurious. I would recommend that water intended for drinking or culinary purposes, be drawn through this improved Tinned Lead Pipe, for there will then be no danger of communicating lead disease, as the water will not be impregnated with the poisonous solutions of lead. It is conceded by all Chemists that lead pipe becomes oxydized by running water, and that the oxide is dissolved in pure water, and more abundantly by water containing carbonic acid gas. The action of various salts in the water, which form a protecting coat over the lead, is neutralized to a great extent by the tremulous motion communicated throughout the pipe by the sudden shutting off of the water. These jars communicated to the pipe displace the carbonate and other salts of lead formed and adherent to the pipes, and diffuse the minute particles through the water, and which, though generally quite invisible, may be detected readily by chemical re-agents. I find that I can always detach a large quantity of lead by simply jarring the pipe while the water is running. There are very many well-marked instances where single individuals, or several members of a family have suffered torture, and have had their health ruined by using water drawn through lead pipes.

[Signed]

SAMUEL R. PERCY, M. D.

From American Druggists' Circular and Chemical Gazette of April 1st, 1865.

ACTION OF WATER ON LEAD.

DR. B. W. RICHARDSON makes (*Med. Times and Gazette*, Oct. 29, 1864) some very interesting and important remarks on this subject. He observes :

"Until recently the popular creed, professional as well as public, on this subject, has been that—

"1. Pure or soft waters alone act on lead, and do so in proportion to their purity or softness.

"A minute proportion of certain neutral salts in water prevents its action on lead. Hence hard or impure waters do not act on lead, and may be safely stored in leaden cisterns and conveyed through leaden pipes.

"In 1858, however, Dr. Lauder Lindsay, of Perth, laid before the British Association the records of a series of experiments and observations made by him on this important subject during the previous year. His main or general results were tabulated in the following series of propositions, viz. that—

"1. Under certain circumstances pure or soft waters *do not* act on lead.

"This was well illustrated by the results of the inquiry instituted in 1854-5 by the Town Council of Glasgow, in connection with the proposed water supply to that city from Loch Katrine. This inquiry cost £5000, and was of the most extensive kind and exhaustive character. It proved *inter alia* that Loch Katrine and other equally pure or soft waters (containing under 2 or $2\frac{1}{4}$ grs. per gallon of solid matter, with a hardness of 0.6 to 0.8 of Clarke's scale) exerted, under given circumstances, no deleterious action on lead.

"2. Hard or impure waters, sometimes containing abundance of the very salts which are generally supposed to be the most preservative or protective, *do act* on lead, and with the same rapidity and efficiency as pure or soft waters. This was illustrated by the destruction of lead cisterns, through the erosive action of hard water, in the Murray Royal Institution (an hospital or retreat for the insane of the middle classes,) near Perth, of which Dr. Lindsay is the physician. This early destruction of lead first directed his attention to the subject.

"3. We are in possession of no satisfactory information anent the causes of the varying action, under different circumstances, of waters on lead; information, that is, which is of any practical use in assisting either in predicating or preventing lead-erosion or lead-contamination.

"4. *Experimentation on the small scale*, and for short periods, is most fallacious, and frequently dangerous in regard to the practical conclusions thence to be drawn.

"5. Contamination of water, both hard and soft, impure and pure, by lead is, in all parts of the kingdom, and under every variety of circumstances, the cause or source of various obscure diseases of man (and also, doubtless, of the lower animals), of the nature especially of dyspepsia and colic. This proposition was abundantly proved by cases of minor diseases induced by lead contamination of various of the hard or impure waters of London.

"6. So uncertain is the action of water on lead, so impossible is it to predicate the nature or extent of that action under the varying mechanical and chemical conditions of water supply of houses and towns, so difficult is it to prevent the possible dangers, so numerous and excellent are the substitutes* that may be provided for lead in the construction of cisterns and pipes, that it is desirable henceforth to *abolish the use of lead as a material for the conveyance or storage of water.*

"This *practical* proposition, to which all the others converge or lead, is now being adopted and acted upon by all our most competent and eminent authorities.

"The Royal Victoria Military Hospital at Netley, which ought to be the embodiment of all modern progress and discovery in sanitary science and hygiene in their applications to the construction of human dwellings, uses *no lead* in its water cisterns or pipes. A writer in *Good Words* says of this hospital: 'The *water supply* has been carefully attended to, and to prevent the possibility of patients suffering from *lead contamination*, not an atom of that metal has been used in the construction either of the pipes or cisterns. The former are made of block tin, and cost £9000. It would be well for the health of the community if in our private houses similar precautions were used.

"The Commissioners in Lunacy for Scotland in their regulations anent the construction of lunatic asylums, remark in regard to water supply: 'It is of the utmost importance that there should be a constant and ample supply of *good water*, of which a careful analysis should be made, with a view to determine the proper materials for pipes and reservoirs, and also in order to ascertain its fitness for the purposes of drinking and washing.' The reporters add: '*Lead is an objectionable material for pipes and reservoirs as adulterating the water.*' Dr. Hassall, the 'Analytical Commissioner' of the *Lancet*, and the author of the well-known standard work on 'Food and its Adulterations,' says: 'From the

* The substitutes in question are of very various kinds. Those most commonly used seem to be— for piping—iron or lead tubes, protected by various innocuous compositions, metallic or otherwise. In the great brewing establishment of Messrs. Allsop & Sons, at Burton-on-Trent, enamelled pipes have been laid throughout their premises. These are iron tubes, enamelled under the patents of Mr. Paris. The enamel, or fused glass, is applied both externally and internally, so that the iron is completely encased: it is incorporated with the metal while it is nearly at a white heat. The same enamel may be applied as a coating for the surface of vessels used for culinary or domestic purposes.— *Builder*, April, 1860.

number of samples of water I have received containing lead, I am induced to believe that that metal is more frequently introduced into the system in this way than is commonly suspected. Indeed, so many well-ascertained cases of *lead poisoning*, arising from the use of water, contaminated with it, have occurred, that I am of opinion that the *use of lead for the storage and conveyance of water ought to be entirely discarded*, especially in the cases of small towns and single houses.

"Again, the late Dr. Dundas Thomson, President of the Metropolitan Association of Medical Officers of Health, who had for many years given, as a chemist, great attention to the subject of water supply, and than whom, on such a subject, there are no more competent authorities, remarks: '*It is impossible too strongly to condemn the use of lead pipes and cisterns. They should never be used for conducting and retaining water for drinking and culinary purposes. It is difficult to understand the origin of the employment of a poisonous metal for domestic use.* But its disuse must depend upon the substitution of the builder or iron pipe fitter for the plumber, who has too long monopolized the manufacture of this noxious form of cistern.

"The Americans apparently attribute a greater value to this subject than we do, having devoted a goodly volume to the now bulky evidence *pro* and *con*.

"In 1859-60 the great lead and water question was the subject of much public discussion in the columns of the *Times*. The result was a general feeling that the public safety lay in *abolition of lead in the construction of cisterns and pipes for water supply*—some writers going so far as to recommend a *prohibition by Government* of such use of lead."—*American Journal of Med. Science*.

THE EXHIBITION OF WILLARD & SHAW'S TIN LINED LEAD PIPES before the *Polytechnic Association of the American Institute*, called forth the following remarks, which we extract from the very able *Report of their Committee* on the "Chemistry of Lead Pipe."

"In conclusion, your Committee would report, that, after having carefully examined both foreign and domestic authority, *they are forced to the conclusion, that it is far safer to abandon the use of lead pipe* than to depend upon the chance of having the water drawn through the pipe before using it, as recommended by the advocates of its use; and further, *your Committee are strongly in favor of recommending the use of lead pipe, covered in the inside with tin, in the manner exhibited before this Association, by Messrs. WILLARD & SHAW, as not only answering all the requirements of the plumber, but at the same time completely obviating all risk of danger, and this, too, at little or no advance of cost over the common lead pipe.*"

The following statement also occurs in the Report :

"The Chairman of your Committee* has very frequently tested the Croton water for lead, and seldom, if ever, failed to detect its presence when drawn through lead pipes."

Although it is doubtful if there is an intelligent adult in our large cities, whose mind has not frequently reverted to the use of lead pipe for conveying water, with serious apprehension of its effect on his own health, it is by no means desirable to create undue fears and consequent conceits. Parties who are erecting buildings should investigate this subject, and if they do so, there will be no delay in the introduction of Messrs. WILLARD & SHAW's Tin Lined Lead Pipe, when it can be obtained at a little or no advance of cost over the common lead pipe.

Parties desiring further particulars respecting Messrs. WILLARD & SHAW'S Improvement, Price Lists, Regular Sizes, or information relative to furnishing Pipes for special purposes, will please address

COLWELLS, SHAW & WILLARD,

348 West 27th Street, New York.

* Professor EVERETT.