CHLORINE
CONTROL APPARATUS
For Water and Sewage Purification

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Wallace & Tiernan Co. INC
NEW YORK

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Gift

Chlorine Control Apparatus

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The value of liquid chlorine in the destruction of germ life in water is a discovery of comparatively recent date. Yet current investigation and experience show it to be the most efficient agent available.

Liquid chlorine is rapidly superseding the use of chloride of lime and other methods dependent on the introduction of solids in admixture with the water.

The application of liquid chlorine to the water to be purified is, however, ordinarily fraught with difficulties arising from the very activity of the gas itself. Though very real, these difficulties are entirely overcome in the design and construction of the control apparatus manufactured by Wallace and Tiernan—the only appliances on the market at the present time adequate to meet all the requirements of handling chlorine in the liquid or gaseous state for the purification of water and sewage.

Messrs. Wallace and Tiernan especially invite consideration, by engineers and others interested in water purification, of the details of design and the perfection of mechanical construction. These matters are discussed fully in succeeding pages.

The other notable feature in the apparatus offered is the variety of available types to meet varied needs and requirements.

There is set forth in the present publication a description of the different types of Wallace and Tiernan apparatus, following a general discussion of the history, theory, and practice of utilizing chlorine for water purification.

HISTORY

The use of liquid chlorine is an evolution of the process of sterilization by chlorination. Various compounds of chlorine—notably calcium hypochlorite or 'chloride of lime'—were largely used at first, and were applied in solution to the water or sewage to be treated. But this method involved so many difficulties and presented so many unsatisfactory features that liquid chlorine is now gradually supplanting these various compounds.

In 1896, James Hargreaves of Liverpool, England, in a paper read before the Liverpool Polytechnic Society, discussed the disinfection of sewage by means of chlorine manufactured by the electrolysis of salt.

One of the first investigations into the sterilization of water and sewage by chlorine and its compounds in this country was carried on by Prof. Earle B. Phelps in 1906 and 1907, and the development of the process is largely due to the published data and reports of his work.

The first recorded attempt, in this country, to sterilize water on a large scale by the process of chlorination was made at the Bubbly Creek water filtration plant at the Union Stock yards, Chicago. Calcium hypochlorite was the compound used in this case, and the results accomplished justified the acceptance of the process as a highly important method of water purification.

Further research into the utilization of pure chlorine as a sterilizing agent was done by Dr. C. R. Darnall, Major of the Medical Corps, U. S. A., in 1910. Under Dr. Darnall's supervision an experimental apparatus for applying chlorine gas to water was constructed at Fort Myer, Va. A board of officers, appointed by the Secretary of War to investigate the operation of the apparatus, reported favorably and recommended the adoption of this method of water treatment.

Further experiments along this line were made in 1911 and 1912 by several independent investigators—notably C. F. Wallace, M. F. Tiernan, George Ornstein, Seth M. VanLoan, John A. Kienle, and D. D. Jackson.

Developments in the process and in the apparatus necessary for the application of liquid chlorine were rapidly made. At the present time, over two billion gallons of water are being sterilized daily by this method.

LIQUID CHLORINE *vs.* CHLORIDE OF LIME

Liquid chlorine is a far more efficient and economical sterilizing agent than chloride of lime. Some of its specific advantages may be briefly discussed.

In the first place liquid chlorine is an absolutely pure chemical. It is usually placed on the market in small cylinders which require very little space for storing, while chloride of lime is very bulky.

The disagreeable odors and corrosive effects of chloride of lime are absent in the use of liquid chlorine, when controlled by efficient apparatus.

Chloride of lime deteriorates rapidly, whereas liquid chlorine retains its full efficiency indefinitely. This is one of the greatest advantages to be derived from the use of liquid chlorine, especially for small installations.

Under working conditions, due to necessary waste of bleach, one pound of liquid chlorine is equal in sterilizing value to eight pounds of chloride of lime. The sterilization is also more uniform.

Water treated with liquid chlorine is less liable to taste or odor, due to the more accurate control possible.

The liquid chlorine apparatus is far more compact than the installation for chloride of lime.

The liquid chlorine process is applicable under any conditions and all pressures. It is adapted to remote control. The gas can be controlled by automatic feed.

With liquid chlorine the freezing difficulties encountered in the use of chloride of lime are entirely obviated.

As between the two sterilizing agents, the costs of chemicals are about the same, but the costs of installation and operation are greatly in favor of liquid chlorine.

METHOD AND APPARATUS

Chlorine gas, compressed to liquid state in iron cylinders holding a hundred pounds, is controlled and measured by the apparatus and introduced into the water or sewage in the proper proportion to effect sterilization.

There are two general types of apparatus, one by which the chlorine gas is introduced directly into the water or sewage and the other by which the chlorine gas is first dissolved in a small quantity of water and the resulting chlorine solution piped to the point of application, the first type being called a dry feed and the second type a wet feed.

Each general type is furnished for either manual or automatic control—the automatic being a proportional feed apparatus, that is, it varies the flow of chlorine in proportion to varying flows of water or sewage.

ADVANTAGES IN CONSTRUCTION

There are many advantages in the construction and design of all Wallace and Tiernan apparatus to which especial attention is directed.

Simplicity in Design. There are no moving parts to get out of order or adjustment.

Compactness. Shipment by express is easy and inexpensive. The apparatus can be sent completely assembled, ready for operation. Installation is a matter of hours and minutes—not of weeks and days. The apparatus may be installed at any convenient point on the premises and the chlorine piped to point of application, even as far as two hundred yards.

Portability. The weight of the apparatus is less than 100 pounds.

Meters Hydraulic in Principle. All chlorine meters operate on the hydraulic principle. There are no moving mechanical parts to cause friction, wear, or strain. If the meter indicates at all, it indicates correctly.

Empirical Calibration. The chlorine meter on every apparatus is empirically calibrated, and then checked during the efficiency test.

Visibility. All chlorine flow meters and orifices are entirely visible making it possible to actually see at all times that the meter is working perfectly in every detail, and is clean and free from deposit. This point cannot be overemphasized.

Dry Control Parts. All control parts of the apparatus are kept perfectly dry, thus avoiding corrosion—for it is only in the presence of moisture that chlorine is so extremely corrosive.

Constant Drop in Pressure. Each type of apparatus has a differential pressure reducing valve which maintains a constant drop in pressure across the chlorine control valve. This produces a constant flow of chlorine for any setting of the control valve regardless of varying pressures in the chlorine cylinders or of varying back pressures from the water being treated. A change in static head in either the system of chlorine apparatus or water in no way affects this predetermined drop across the control valve. This drop being about a pound allows a considerable opening of the control valve for comparatively low flows of chlorine. Thus, dangers of stoppage are minimized.

Special Materials. Special metals and materials, such as platinum, quartz, silver, tungsten, and alloys particularly adapted for chlorine control work are used where best suited to the needs in question.

Finish. Parts are finished in silver plate and black enamel.

Interchangeable Parts. The apparatus is built on the unit system and all parts are perfectly interchangeable.

Workmanship. The highest class of workmanship is employed in making all parts of the apparatus. Each apparatus, before shipment, is given an actual chlorine run by experts who have actually installed and operated chlorine plants on water and sewage treatment.

The various types of apparatus will now be described in detail.

MANUAL CONTROL CHLORINATOR DIRECT FEED—TYPE A

Chlorine gas in the cylinder *A* controlled by valve *G* is measured on flow meter *F* through the orifice *O* and piped through tube *K*, check valve *L*, and silver tube *M*, to the point of application where it is dissolved and diffused by the chlorine diffusor *R*. Any number of chlorine cylinders of any size may be connected up at a time by means of a suitable header.

The automatic three-way valve *C* is quite an essential part of the apparatus inasmuch as it ensures a constant supply of chlorine. If a cylinder on one side of the valve becomes used up at a time when there is no attendant present, the valve *C* automatically throws over, cutting in a new cylinder. When the attendant sees the valve thrown over he simply attaches a new cylinder of chlorine which in turn will be cut in when the second cylinder becomes exhausted.

The gage *N* has electrical contacts for ringing a bell if desired to give warning of any failure in the flow of chlorine from the cylinders. Gauge *H* will instantly indicate any stoppage in the chlorine line to the water.

The chlorine meter *F* is of the enclosed manometer type. One side is connected ahead of the orifice *O* and the other side after the orifice. The drop in pressure across this orifice is indicated by a column of liquid in the manometer. The different positions of the liquid indicate different flows of chlorine. This calibration is done empirically for each apparatus and checked by actual chlorine flow when the apparatus is tested.

The orifice is visible so that there need be no doubt as to its being perfectly clean. Being of glass, it does not corrode. Its most accurate range is from 1-6, *e. g.* if the minimum graduation is 5, the maximum is 30. Should it be necessary to increase or decrease the capacity of the apparatus without affecting its sensitiveness, the glass cap *I* is screwed off and a larger or smaller orifice inserted and the corresponding scale attached on *F*.

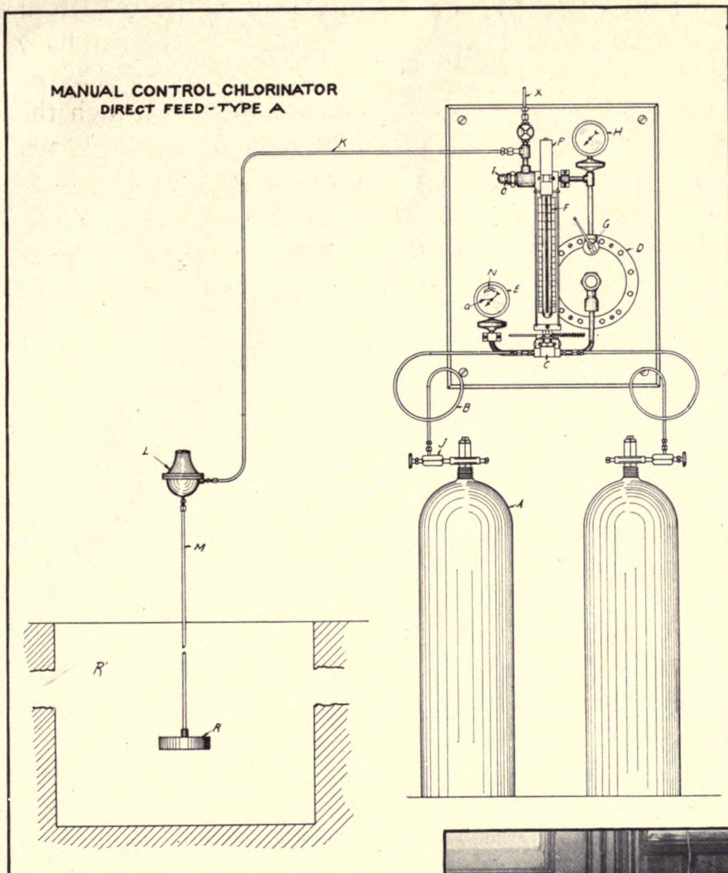
The tubing *K* may be of copper or ordinary galvanized iron pipe. Chlorine does not attack these metals when dry. The check valve *L* prevents any moisture from getting into this pipe. The dry gas may be piped most any distance without danger of freezing.

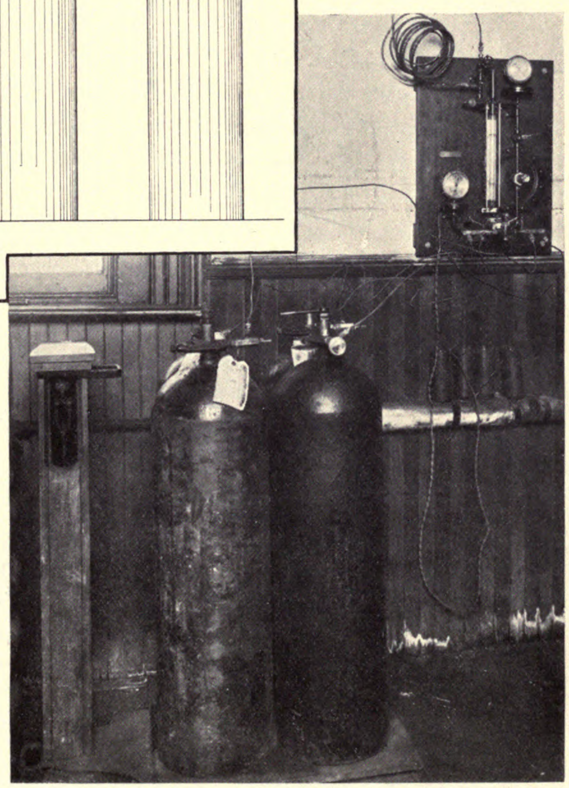
The diffusor *R* may be dropped into a pump well, gate chamber, open conduit, or stream. In sewage disinfection an inverted siphon arrangement as shown on page 27 may be used.

Perfect solubility of the gas is obtained at a depth of four feet, and no gas will come to the surface. The diffusor *R* is a carborundum sponge of fine porosity. This becomes saturated with water because of the capillary action of the carborundum upon the water. The natural pressure of chlorine in the cylinder forces the chlorine in the most minute bubbles through the carborundum in which passage they become saturated with moisture. When they strike the water, they go immediately into solution, not only on account of their fineness but also because they are already saturated.

The apparatus illustrated is installed at the Smith's Pond Pumping Station, Brooklyn, N. Y. Its capacity is fifty million gallons daily.

A—chlorine cylinders
J—auxiliary tank valve
B—flexible connection
C—automatic 3-way valve for cutting out empty cylinders and cutting in full cylinders automatically
E—pressure gauge showing pressure of chlorine in cylinders
G—control valve
D—pressure compensating valve for maintaining a constant drop in pressure across the control valve *G* regardless of the varying pressures in the cylinders
H—back pressure gauge
F—chlorine flow meter calibrated empirically
O—visible glass orifice through which chlorine is measured
I—removable glass cap over orifice *O*
X—chlorine relief line
K—chlorine line
L—check valve
M—silver tubing
R—chlorine diffusor (carborundum sponge)
Size—apparatus mounted on board 18 x 24 inches


MANUAL CONTROL CHLORINATOR
DIRECT FEED - TYPE A



MANUAL CONTROL CHLORINATOR
DIRECT FEED—TYPE B

The control parts of this apparatus are the same as in the manual control chlorinator, direct feed, Type A, described and illustrated on pages 7-9.

The tank *T* acts as a trap to prevent flooding of the chlorine apparatus in case of a failure of the check valve *L* at any time when the chlorine might be turned off. The gauge *U* will instantly indicate any stoppage in chlorine line between apparatus and the water, or any trouble with the check valve *L*.

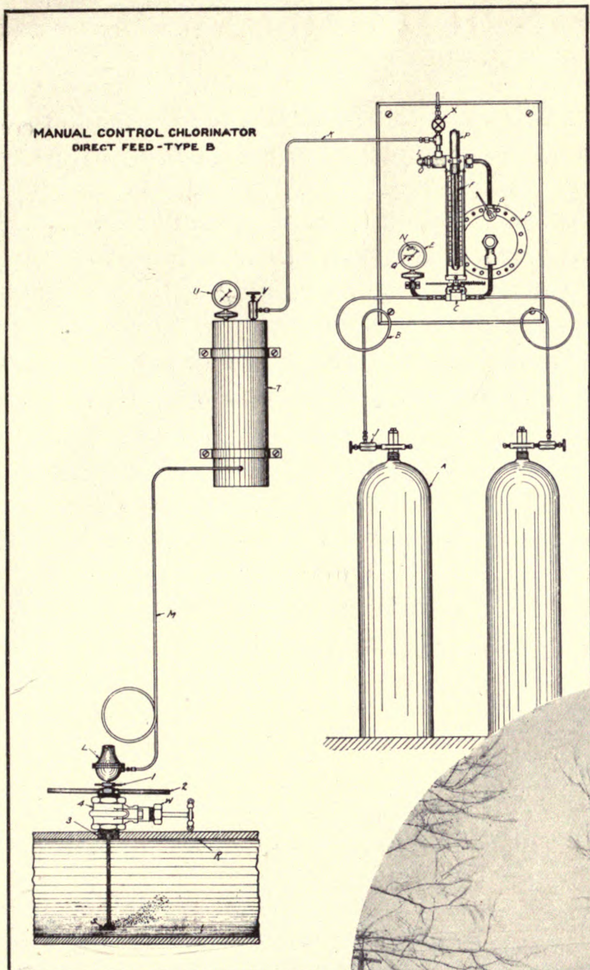
The nipple *3* is inserted in a 2-inch or 2½-inch tapping. There is sufficient space between the gate of the valve *4* and the cap *2* to hold the diffusor *S*, so that the diffusor may be inserted or withdrawn from the main without loss of water by simply loosening the stuffing box *1*, pulling up diffusor above the gate *4*, closing the gate, and then unscrewing cap *2*.

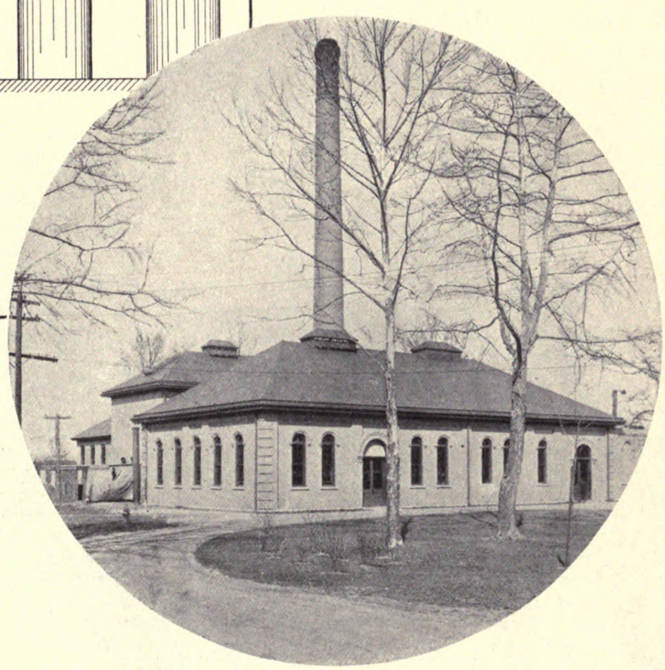
The chlorine gas bubbles from the diffusor *S* rise vertically in still water at the rate of 24 ft. per minute. In a main where there is flowing water, these bubbles are swept along and diffuse through the water before reaching the top of the main. This gives a most excellent distribution and consequently most efficient disinfection of water.

There is also an increased rate of solution of the chlorine because of the fact that the chlorine is introduced into the water under pressure, the rate of solubility being according to the well known chemical law of solubility of gases in liquids under pressure.

By this apparatus chlorine can be introduced directly into the main against pressures up to twenty-five pounds.

A—chlorine tanks
J—auxiliary tank valve
B—flexible connection
C—automatic 3-way valve for cutting in full cylinders and cutting out empty cylinders automatically
E—pressure gauge showing pressure of chlorine in cylinders
F—chlorine flow meter calibrated empirically
D—pressure compensating valve for maintaining a constant drop in pressure across the control valve *G* regardless of the varying pressures in the cylinders
G—control valve
O—visible glass orifice through which chlorine is measured
I—movable glass cap over orifice *O*
X—chlorine relief line
K—chlorine line
V—valve
T—chlorine trap tank
U—back pressure gauge
M—chlorine line
L—check valve
W—gate valve
S—chlorine diffusor
R—water main
Size—apparatus mounted on board 18 x 24 inches


MANUAL CONTROL CHLORINATOR
DIRECT FEED - TYPE B

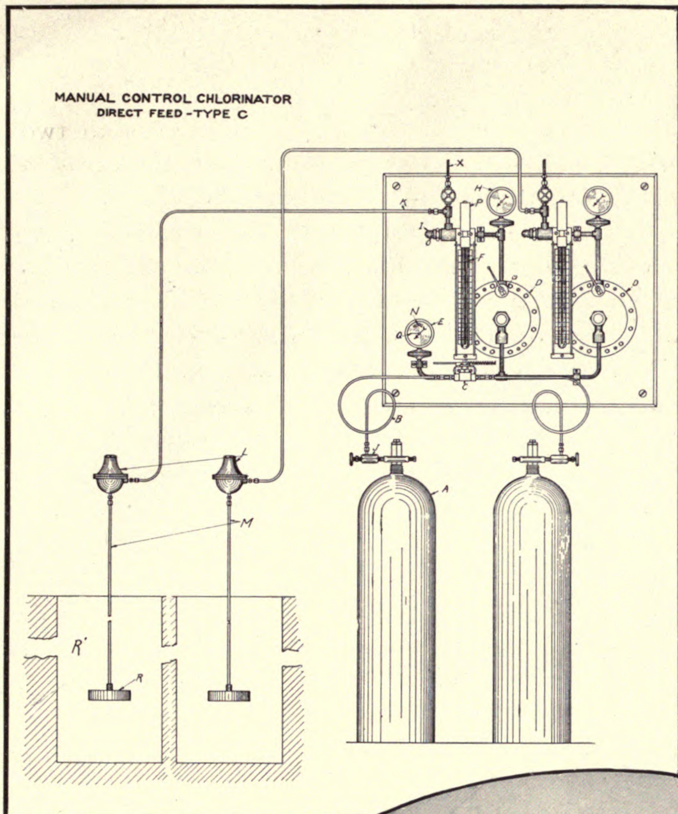


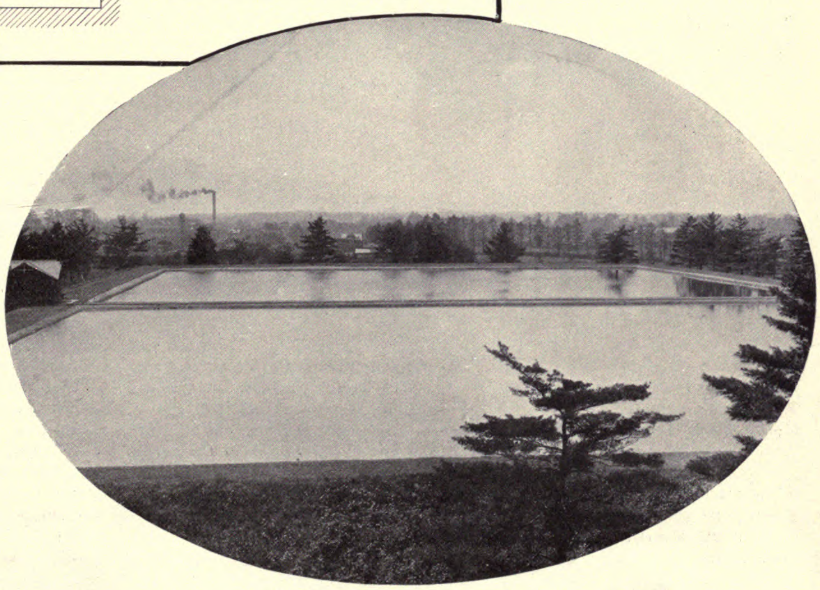
MANUAL CONTROL CHLORINATOR DIRECT FEED—TYPE C

It is sometimes desirable or necessary to introduce the chlorine at two different points as in parallel conduits or mains or to have an apparatus in duplicate drawing from one source of chlorine. The advantages of this are obvious, especially where constant disinfection is an absolute necessity.

By means of a duplicate apparatus as shown either unit may be run independently or both may be run at one time. Should anything happen to one unit, the other could be used to control the chlorine while the first was being repaired. By simply breaking a connection either unit can be detached and returned to the factory for repair or replacement.

A—chlorine cylinders
J—auxiliary tank valve
B—flexible connection
C—automatic 3-way valve for cutting out empty cylinders and cutting in full cylinders automatically
E—pressure gauge showing pressure of chlorine in cylinders
G—control valve
D—pressure compensating valve for maintaining a constant drop in pressure across the control valve *G* regardless of the varying pressures in the cylinders
H—back pressure gauge
F—chlorine flow meter calibrated empirically
O—visible glass orifice through which chlorine is measured
I—removable glass cap over orifice *O*
X—chlorine relief line
K—chlorine line
L—check valve
M—silver tubing
R—chlorine diffusor (carborundum sponge)
Size—mounted on board 24 x 28 inches


MANUAL CONTROL CHLORINATOR
DIRECT FEED-TYPE C



AUTOMATIC CHLORINATOR
DIRECT FEED—TYPE A

The control parts of this apparatus are the same as in the automatic venturi operated type described and illustrated on pages 16-17.

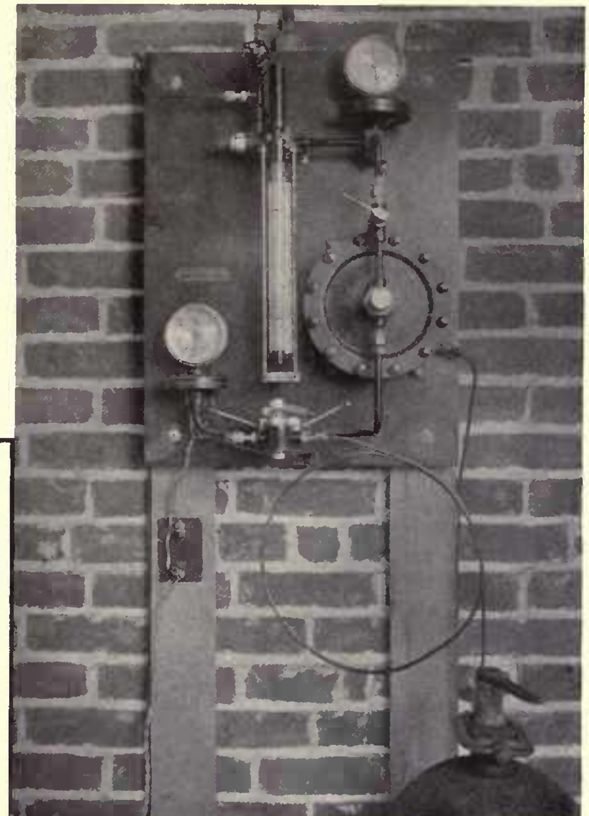
The law governing the discharge of liquid with varying head through an orifice is practically the same as that for the flow through a venturi throat. Hence, if this head over the orifice is transmitted to suitable diaphragms in the valve *D*, proportional flows of chlorine and water will be obtained—the same as in the venturi operated automatic apparatus described on pages 16-17.

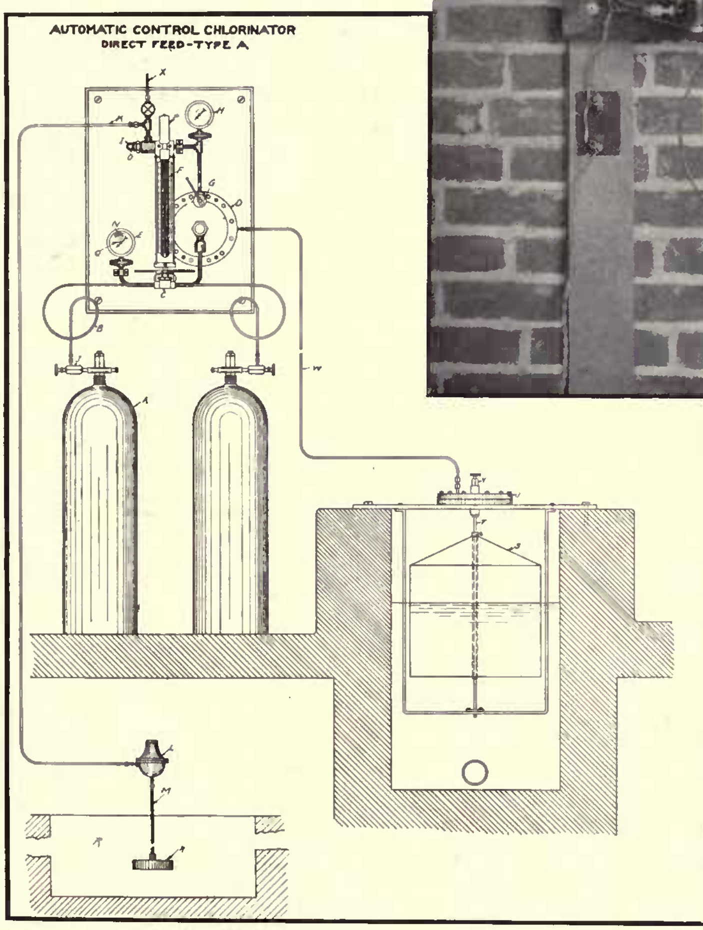
The thrust from the float *S* is transmitted by a diaphragm in *U* and a capillary tube *W* to the valve *D* where it actuates diaphragms suitably arranged so that the head over the submerged orifice and the difference or drop in pressure across the chlorine gas constriction in the valve *G* are kept proportional. This gives proportional flows of chlorine for varying heads over the submerged orifice.

When a weir is used instead of a submerged orifice, the float *S* is cut in the right shape to give the proper thrust to the diaphragm *U* for any head over the weir.

The chlorine apparatus may be located any distance desired from the float well.

A—chlorine cylinders
J—auxiliary tank valve
B—flexible connection
C—automatic 3-way valve for cutting in full cylinders and cutting out empty cylinders automatically
E—pressure gauge showing pressure of chlorine in tanks
F—chlorine flow meter calibrated empirically
D—pressure compensating valve for maintaining a constant drop in pressure across the control valve *G* regardless of the varying pressures in the cylinders
H—back pressure gauge
O—visible glass orifice through which chlorine is measured
I—removable glass cap over orifice *O*
X—chlorine relief line
K—chlorine line
L—check valve
M—silver tubing
R—chlorine diffusor (carborundum sponge)
S—float
T—connection
U—diaphragm
V—relief valve
W—capillary tubing




AUTOMATIC CONTROL CHLORINATOR
DIRECT FEED-TYPE A

AUTOMATIC CONTROL CHLORINATOR DIRECT FEED—TYPE B

This type of apparatus is designed to vary the flow of chlorine in proportion to varying flows of water. As shown in the drawing, it operates in conjunction with a venturi throat.

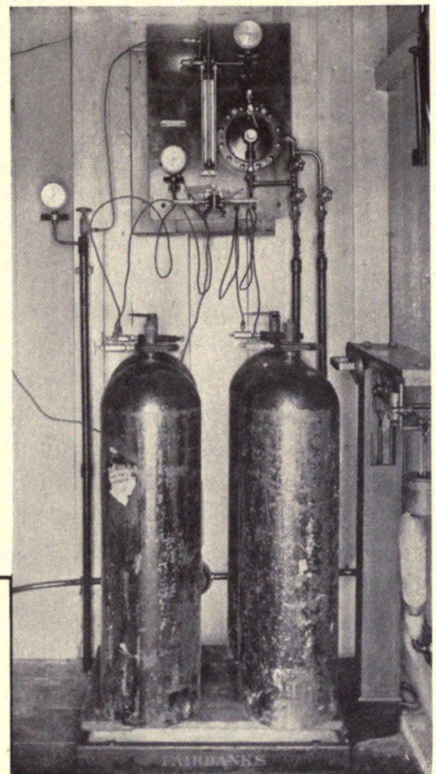
The arrangement of the different parts of the apparatus and the method of securing solubility of the chlorine are the same as in the manually operated type (described and illustrated on pages 7-9) and of essentially the same construction with the exception of the automatic regulating valve. In this valve *G* is a gas constriction of such design that the drop in pressure across it for any flow of chlorine follows the same law as the drop in pressure across the venturi for any flow of water. By keeping these drops or differences in pressure proportional to each other, a proportional flow of chlorine and water is obtained. In other words, the water is treated with the same proportion of chlorine, no matter what its flow at any instant.

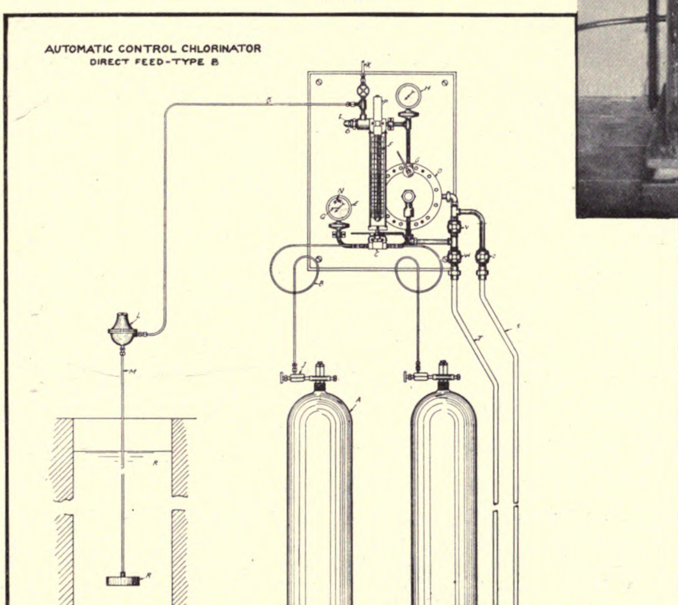
Suitable diaphragms, one set actuated by connections to the venturi tube and another set actuated by connections to the chlorine constriction are so connected to a valve in the chlorine line that any difference in flow of either the water or chlorine throws the diaphragms out of equilibrium, and there is allowed to pass a greater or less amount of chlorine until the diaphragms come again into equilibrium.

This valve will likewise take care of varying pressures of chlorine in the cylinders as well as varying flows of water. It also acts as a differential pressure reducing valve.

The automatic control does not depend upon the opening or closing of a valve a certain number of turns. Consequently any deposit in the valve seat or any corrosion in no way affects the accuracy of the control. There are no moving parts and no electrical or other delicate devices to get out of order or adjustment. All the parts are self-contained, absolutely dry, and away from the danger of anyone interfering with them.

A—tanks of chlorine
J—auxiliary tank valves
B—flexible connection
E—pressure gauge showing pressure of chlorine in cylinders
C—automatic 3-way valve for cutting out empty and cutting in full cylinders automatically
F—chlorine flow meter calibrated empirically
D—differential pressure compensating valve for maintaining proportional flows of chlorine and water
G—control valve
H—pressure gauge showing back pressure from check valve *L*
O—visible glass orifice through which chlorine is measured
I—removable glass cap over orifice
X—chlorine relief line
K—chlorine line to check valve
L—check valve
M—silver tubing
R—chlorine diffusor
U—venturi tube
S-T—water connections
W-Z-V—water valves
Size—mounted on board 18 x 24 inches




AUTOMATIC CONTROL CHLORINATOR
DIRECT FEED-TYPE B

MANUAL CONTROL CHLORINATOR SOLUTION FEED—TYPE A

Chlorine gas in cylinder *A*, controlled by valve *S*, is introduced through the check valve *G* and meter *J* into the chlorine absorption chamber *I* and water at the same time is introduced through the connection *V*. The resulting chlorine solution is piped through the tube *U* to the point of application. When the chlorine solution is introduced into a suction line under a negative head a water seal *N* is provided to prevent air being drawn into the suction line.

In the treatment of water a chlorine flow meter, to be reliable, must give a constant rate—not per day, nor per hour, nor per minute—but even less than per second, for the obvious reason that the water is flowing constantly and must receive its chlorine constantly and not intermittently.

The chlorine absorption chamber *I* and meter *J* are made of special annealed glass. They are consequently absolutely unattacked by the chlorine solution. Furthermore, the flow of chlorine can be actually seen no matter how small. A flow of one pound of chlorine per twenty-four hours (which amount will treat 300,000 gals. of water) is a flow of .000694 lbs. per minute or .0000115 lbs. per second. This quantity is entirely too minute to measure by any method but a volumetric one.

The type meter used will indicate accurately from 1/10 lb. of chlorine per 24 hrs. (.00000115 lbs. per second) up to 12 lbs.

The operation of this meter is fully described and illustrated on page 26.

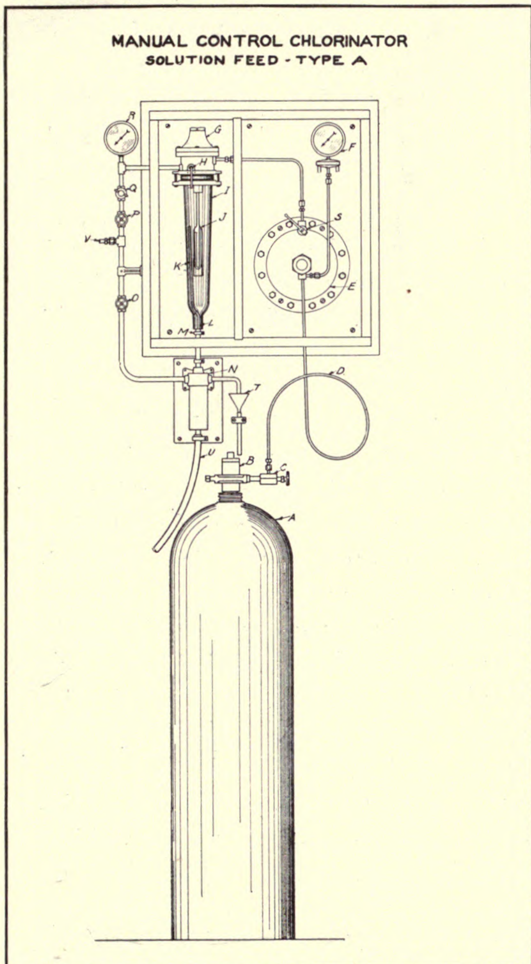
A ready solubility of chlorine is secured by the action of a water jet which thoroughly churns up the chlorine and water in the jar.

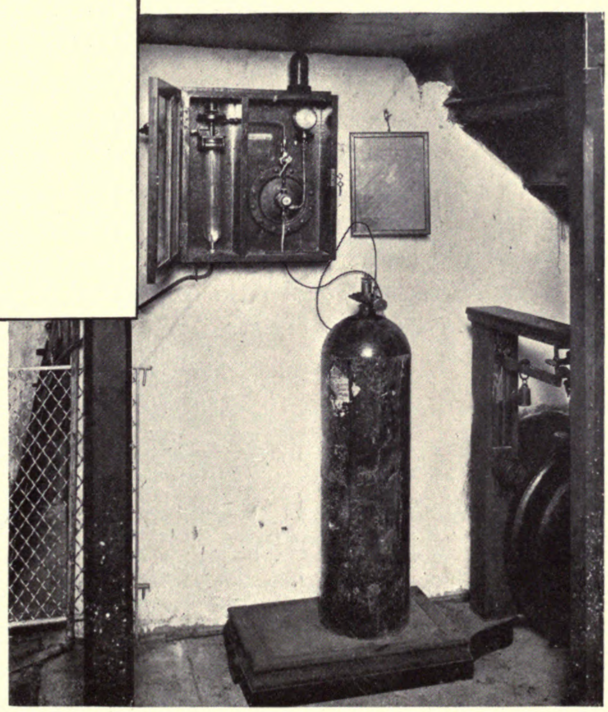
The illustration shows the apparatus in operation at the Bridgeton (N. J.) Filtration Plant.

S—control valve
A—chlorine tank
B—valve on chlorine tank
C—auxiliary valve
D—flexible connection
E—pressure compensating valve for taking care of the varying pressures in the chlorine tank and also maintaining a constant drop in pressure across the valve *S*

S—control valve
G—valve to prevent moisture from getting back into control parts of apparatus
H—valve to control flow of water and to keep chlorine out of incoming water connections
F—pressure gauge showing pressure in tank
J—chlorine flow meter (inverted siphon type)

I—chlorine absorption chamber
K-L—chlorine solution line
V—water connection
P—water valve
R—gauge
O—water valve to water seal *N*
T—water spill
U—chlorine solution line to point of application.
N—water seal
Size—apparatus mounted in wall cabinet 20 x 21 inches


MANUAL CONTROL CHLORINATOR
SOLUTION FEED - TYPE A



MANUAL CONTROL CHLORINATOR SOLUTION FEED—TYPE B

The chlorine control features of this apparatus are the same as those of the manual control chlorinator, direct feed, Type A, described and illustrated on pages 7-9.

The chlorine gas in place of being introduced into the water through a carborundum sponge is continuously dissolved in a small amount of water and the resulting solution piped to the point of application through suitable tubing having a grid or distributor on the end—if need be—for securing proper distribution.

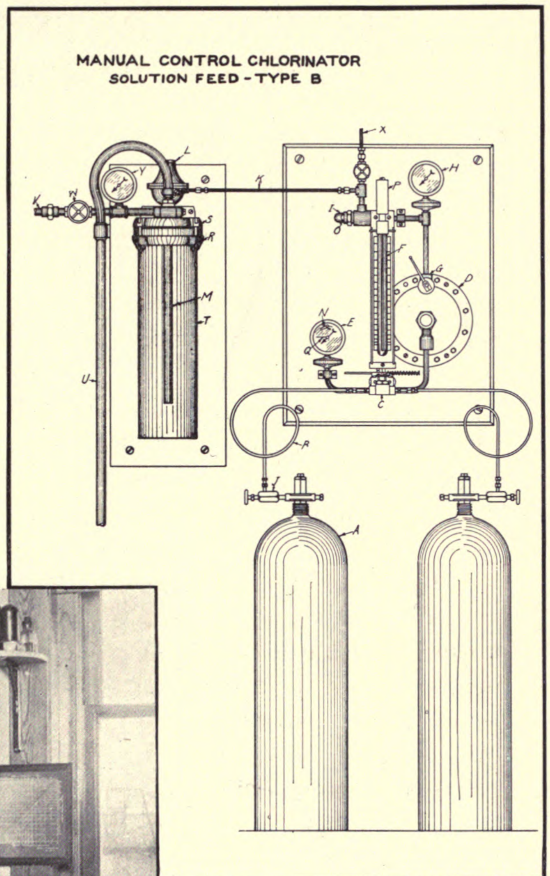
Water under a pressure of fifteen pounds or more and at the rate of forty gallons to one pound of chlorine is introduced into the solution tower simultaneously with the chlorine. A specially designed water jet gives almost instant solubility of the chlorine with the water. The solution is drawn off from a point near the bottom of the tower so that it is impossible for any chlorine in the gaseous state to enter the water being treated.

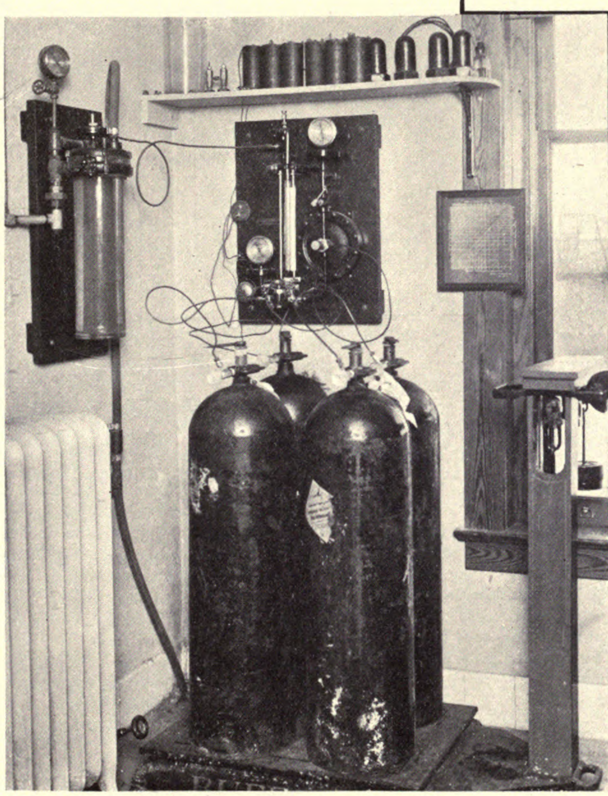
The check valve *L* is attached to the top of the casting at the head of the absorption chamber to prevent moisture from getting back into the control mechanism of the apparatus. The glass jar *T* can be very easily and quickly removed for inspection of interior parts or replacement. The fact that the jar is of glass makes the solubility of the chlorine actually visible.

The system being a closed one makes it possible to pipe the chlorine solution a considerable distance without the need of pumps. The chlorine measuring device and the absorption device are separate independent units and each may be located at any desired point.

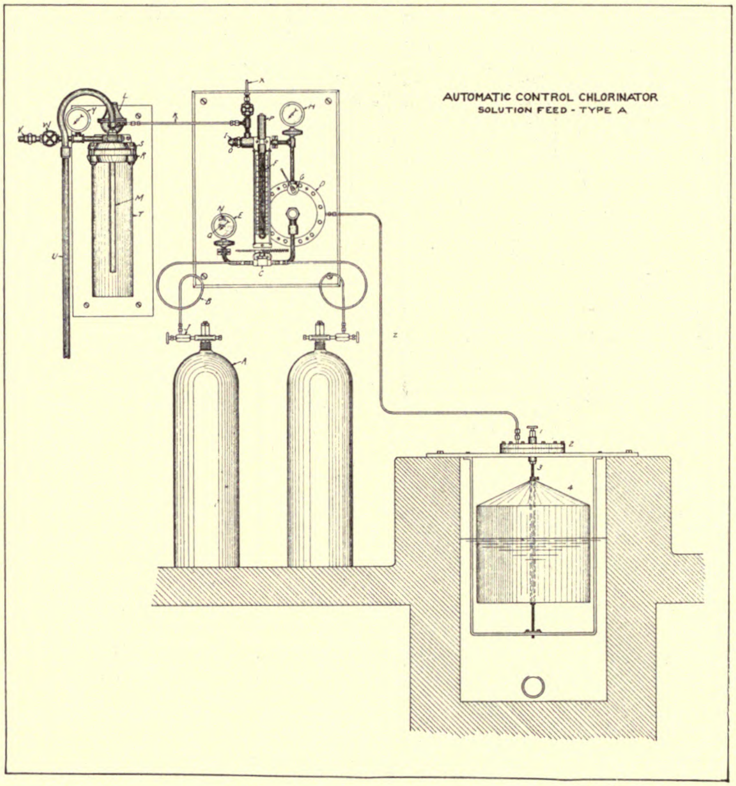
The illustration shows the apparatus in operation at the Trenton (N. J.) Filtration Plant, treating approximately 25,000,000 gallons of water daily.

A—tanks of chlorine
J—auxiliary tank valves
B—flexible connection
E—pressure gauge showing pressure in chlorine tanks
C—automatic 3-way valve for cutting out empty and cutting in full cylinders of chlorine
D—pressure compensating valve for maintaining constant drop in pressure across control valve *G*
G—chlorine control valve
H—pressure gauge showing back pressure from check valve *L*
F—chlorine flow meter calibrated empirically
O—visible glass orifice through which chlorine is measured
I—removable glass cap over *O*
X—chlorine relief line
K—chlorine line
L—check valve
S-R-T—chlorine absorption chamber
V—water connection
W—water control valve
Y—water pressure gauge
M-U—chlorine solution line to point of application
Size—Chlorine apparatus mounted on board 18 x 24 inches; solution tower on board 10 x 26 inches


MANUAL CONTROL CHLORINATOR
SOLUTION FEED - TYPE B



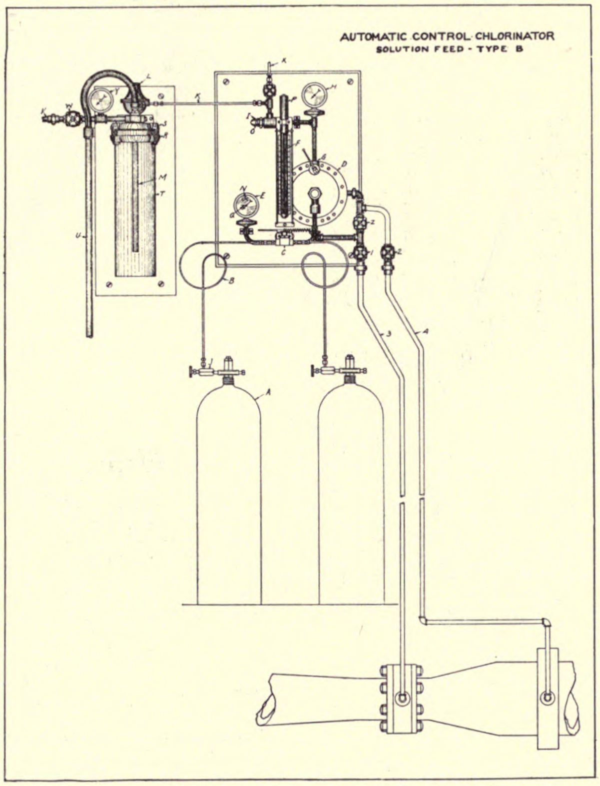
AUTOMATIC CONTROL CHLORINATOR
SOLUTION FEED—TYPE A



The automatic parts of this apparatus are the same as for the automatic control chlorinator, direct feed, Type A, described on pages 14-15, and the method of securing the solution of the gas the same as for the manually operated chlorinator, solution feed, Type B, described on pages 20-21.

A—tanks of chlorine
J—auxiliary tank valves
B—flexible connection
E—pressure gauge showing pressure in chlorine tanks
C—automatic 3-way valve for cutting out empty and cutting in full cylinders of chlorine automatically
D—pressure compensating valve for maintaining constant drop in pressure across control valve *G*
G—chlorine control valve
H—pressure gauge showing back pressure from check valve *L*
F—chlorine flow meter calibrated empirically
O—visible glass orifice through which chlorine is measured
I—removable glass cap
X—chlorine relief line
K—chlorine line
L—check valve
S-R-T—chlorine absorption chamber
V—water connection
W—water control valve
Y—water pressure gauge
M-U—chlorine solution line to point of application
Z—capillary tubing
1—relief valve
2—diaphragm
3—connection
4—float
Size—chlorine apparatus mounted on board 18 x 24 inches; solution tower on board 10 x 26 inches

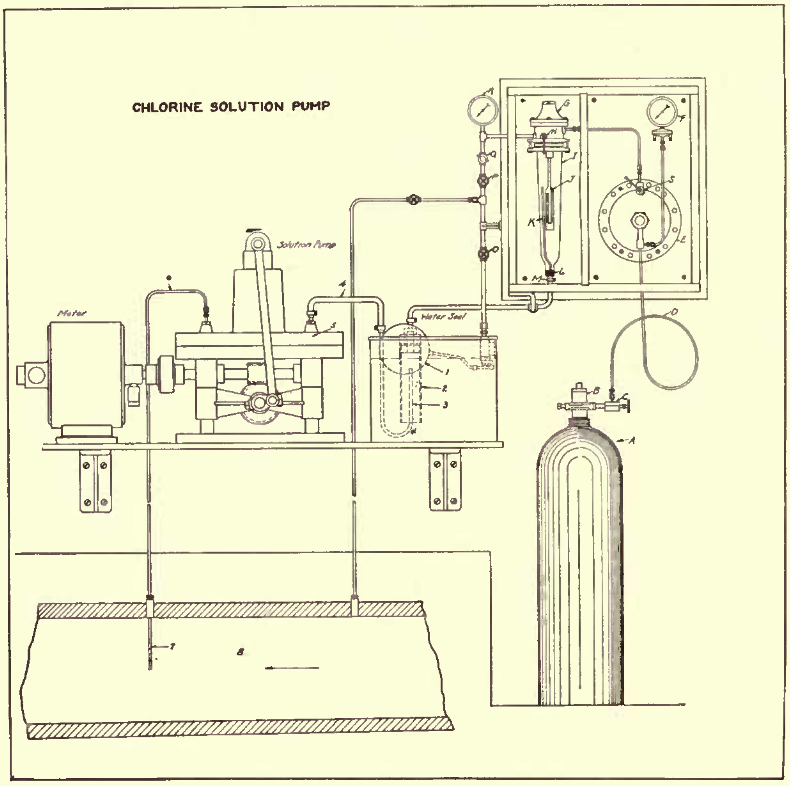
AUTOMATIC CONTROL CHLORINATOR
SOLUTION FEED—TYPE B



The chlorine control parts of this apparatus are the same as for the automatic control chlorinator, direct feed, Type B, described on pages 16-17. The method of securing the solution of the gas is the same as for the manually operated chlorinator, solution feed, Type B, described on pages 20-21.

A—tanks of chlorine
J—auxiliary tank valves
B—flexible connection
E—pressure gauge showing pressure in chlorine tanks
C—automatic 3-way valve for cutting out empty cylinders and cutting in full cylinders of chlorine
D—pressure compensating valve for maintaining constant drop in pressure across control valve *G*
G—chlorine control valve
H—pressure gauge showing back pressure from check valve *L*
F—chlorine flow meter calibrated empirically
O—visible glass orifice through which chlorine is measured
I—removable glass cap over *O*
X—chlorine relief line
K—chlorine line
L—check valve
S-R-T—chlorine absorption chamber
V—water connection
W—water control valve
Y—water pressure gauge
M-U—chlorine solution line to point of application
Z-1-2—water valves
3-4—water connection
Size—chlorine apparatus mounted on board 18 x 24 inches: solution tower on board 10 x 26 inches

APPARATUS WITH CHLORINE SOLUTION PUMP



This chlorine control and absorption device is the same as the regular solution feed, Type A apparatus. It is often desirable or necessary for many reasons to introduce chlorine into the main under pressure. The ordinary pump, either of bronze or vulcanite, is unsatisfactory for this use for the reason that the chlorine under pressure has an extremely corrosive action on certain materials usually employed in pump construction and particularly upon stuffing boxes.

The solution pump developed is a diaphragm pump operated by an oil piston. The inlet and outlet valves are of pure silver, easily replaceable in case of wear. The interior of the pump also is lined throughout with pure silver. There is absolutely no chlorine solution coming in contact with any stuffing box.

The diagram shows the pump being driven by electric motor, but the same pump may be operated with a water motor.

Chlorine solution measured by the chlorine regulating device is introduced into the water seal. This water seal is to prevent air from being drawn into the pump and also is of a design which keeps the chlorine solution away from the atmosphere, so there is no escape of chlorine into the air.

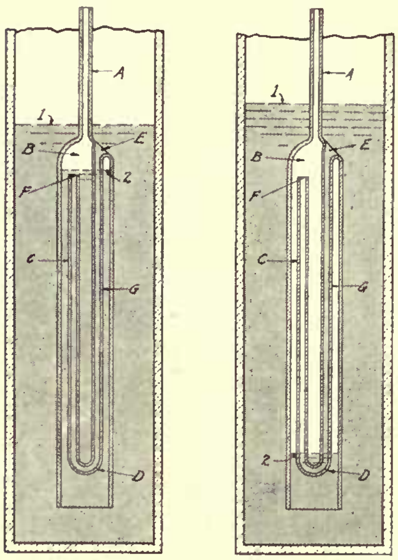
The tubing 7 into the main is of pure silver and the other parts of the apparatus are of special materials particularly adapted for the chlorine control work. This solution pump may be connected up to any chlorine device and, of course, can be made in any capacity. It will operate against any pressure.

A—chlorine cylinders
B—tank valve
C—auxiliary valve on tank
D—flexible connection
E—pressure compensating valve for maintaining a constant drop in pressure across the control valve *S* regardless of the varying pressures in the cylinders
F—pressure gauge showing pressure of chlorine in cylinders
S—control valve
G—check valve
H—water inlet regulator
I—chlorine absorption chamber
J—chlorine meter (inverted siphon type)
K—chlorine solution outlet
L-M—connections
P-O—water valves
Q—screen
R—pressure gauge
1—float
2—water seal for solution line *3-4*
5—solution pump
6—solution line to water main
7—silver distributor
8—pressure main
Size—chlorine apparatus mounted on board 20 x 21 inches; water seal, pump, and motor 12 x 20 x 45 inches

DESCRIPTION OF PULSATING METER

The meter *A* in the chlorine absorption chamber is shown in detail and principle in the accompanying drawing. View X shows the water level *2* in the meter at the beginning of the pulsation, and view Y shows the water level *2* just before the siphon *C–G* breaks at *D*, which completes one pulsation of the meter.

Its operation is as follows. When the downward flowing gas in *A* reaches the point *D*, it will rush up through the tube *G* of the siphon, and the bell or compartment *B* will refill with water up to the upper end of *C*. This completes one pulsation or measure of the meter, and the amount of gas delivered by this one pulsation is, of course, the capacity of the compartment *B* between the points *F* and *D*.



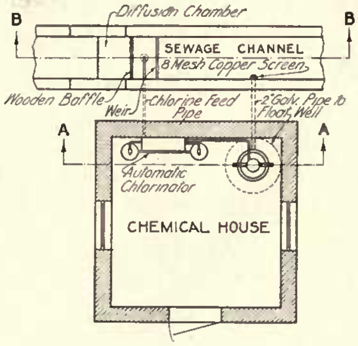
X Y

This is a volumetric meter, hydraulic in principle, and if it operates at all it must operate correctly. Its reading is accurate from a minimum of 1/10 lb. to a maximum of 12 lbs. per 24 hours.

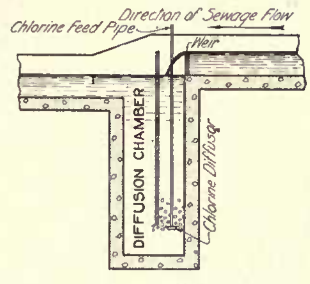
All the openings are large so that there is no danger of stoppage. All parts are of glass, which is in no way affected by the chlorine solution. Furthermore, this plan of construction enables the attendant to actually see the chlorine flowing, no matter how small the amount. This point is essential in reliable chlorine control work.

One pulsation of the meter gives 100 milligrams or 1/4534 lbs. (.00022 lbs.). By simply timing the number of pulsations per minute, and using the chart of operation described and illustrated on pages 28-29, the desired flow of chlorine can be easily and accurately set.

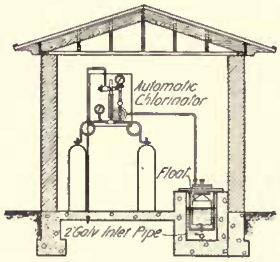
TYPICAL LAYOUT OF AUTOMATIC CHLORINATOR FOR SEWAGE DISPOSAL PLANT



PLAN



SECTION B-B



SECTION A-A

POINT OF APPLICATION MARKED (X)

The various parts of this chlorine layout are essentially the same as in the automatic chlorinator, direct feed, Type A, described and illustrated on pages 14-15.

The chlorine diffusion chamber as shown above gives excellent and ready diffusion of the gas and sewage. The sewage flowing down the right hand side of the invert meets and thoroughly diffuses the chlorine rising from the chlorine diffusor. And before the sewage reaches the top of the invert it is thoroughly mixed with the chlorine, the result being most efficient disinfection.

CHART OF OPERATION

In the treatment of water with chlorine, the quantities added are usually expressed in parts chlorine per million parts water by weight. Since a gallon of water weighs 8.3 lbs., one part chlorine per million parts water is equivalent to 8.3 lbs. chlorine per million gallons of water.

The chart of operation furnished with each apparatus provides a simple and accurate means for determining the number of pounds chlorine per 24 hours to add to any quantity of water to give a desired number of parts per million.

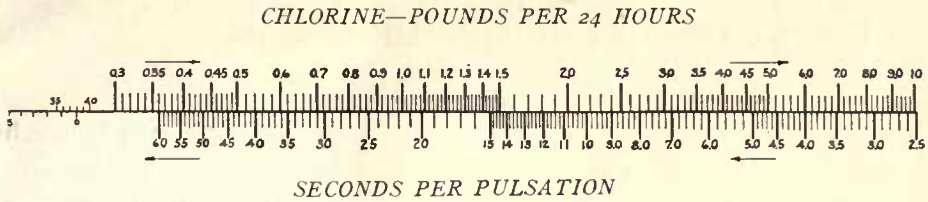
For example, it is desired to treat two million gallons of water with .24 parts chlorine per million parts water. From the intersection of the vertical line from the figure 2 at the bottom of the chart with the horizontal line from the figure .24 at the left side of the chart, follow the oblique line to the right hand side of the chart. The figure here is 4, which is the number of pounds chlorine necessary to add to two million gallons of water in 24 hours to give .24 parts per million.

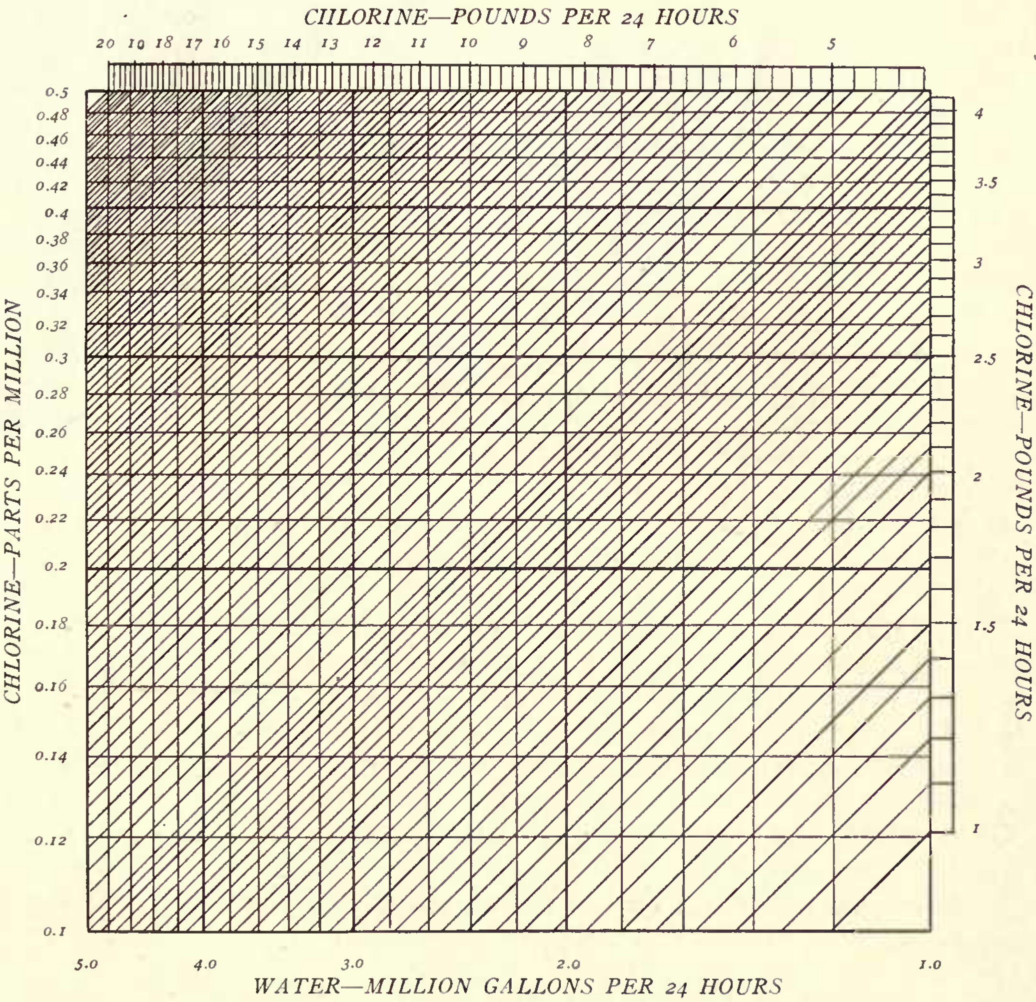
These charts are made for any flow of water, and the graduations on the right and upper sides of the chart are the same as on the orifice flow meter of the apparatus.

When the siphon type meter is used, its rate of delivery is determined by the scale at the top of the opposite page, the pounds chlorine desired being read from left to right on the upper scale, and time per pulsation or measure of the siphon in seconds being read from right to left on the lower scale.

For example, it is desired to treat two million gallons per 24 hours with .24 parts of chlorine. Find on the chart as above described the number of pounds chlorine, which in this instance is 4. On the upper scale, reading from left to right, find the figure 4, and directly under it is the figure 5.7, which is the number of seconds for one pulsation or measure of the meter to give the required feed. This can be read in measures per minute by simply dividing 60 by 5.7, which gives 10.5, the number of measures per minute.

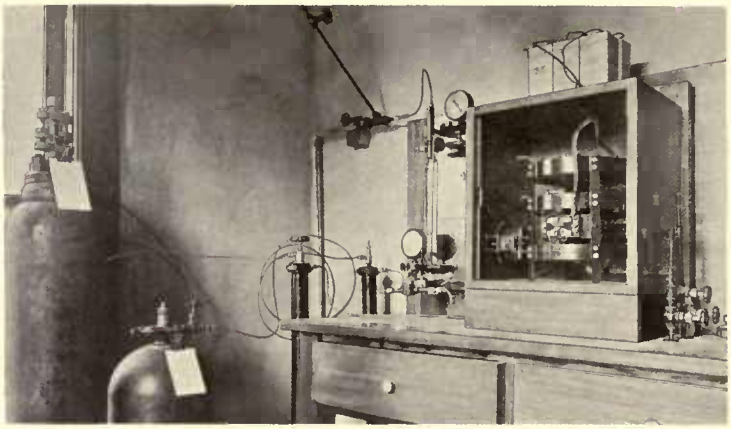
Any workman of ordinary intelligence can properly set the apparatus by means of this simple chart of operation.


CHLORINE—POUNDS PER 24 HOURS
0.3 0.35 0.4 0.45 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 6.0 7.0 8.0 9.0 10
60 55 50 45 40 35 30 25 20 15 14 13 12 11 10 9.0 8.0 7.0 6.0 5.0 4.5 4.0 3.5 3.0 2.5
SECONDS PER PULSATION


CHLORINE—POUNDS PER 24 HOURS
20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5
CHLORINE—PARTS PER MILLION
0.5 0.48 0.46 0.44 0.42 0.4 0.38 0.36 0.34 0.32 0.3 0.28 0.26 0.24 0.22 0.2 0.18 0.16 0.14 0.12 0.1
CHLORINE—POUNDS PER 24 HOURS
4 3.5 3 2.5 2 1.5 1
5.0 4.0 3.0 2.0 1.0
WATER—MILLION GALLONS PER 24 HOURS

A WORKING TEST AT STAMFORD

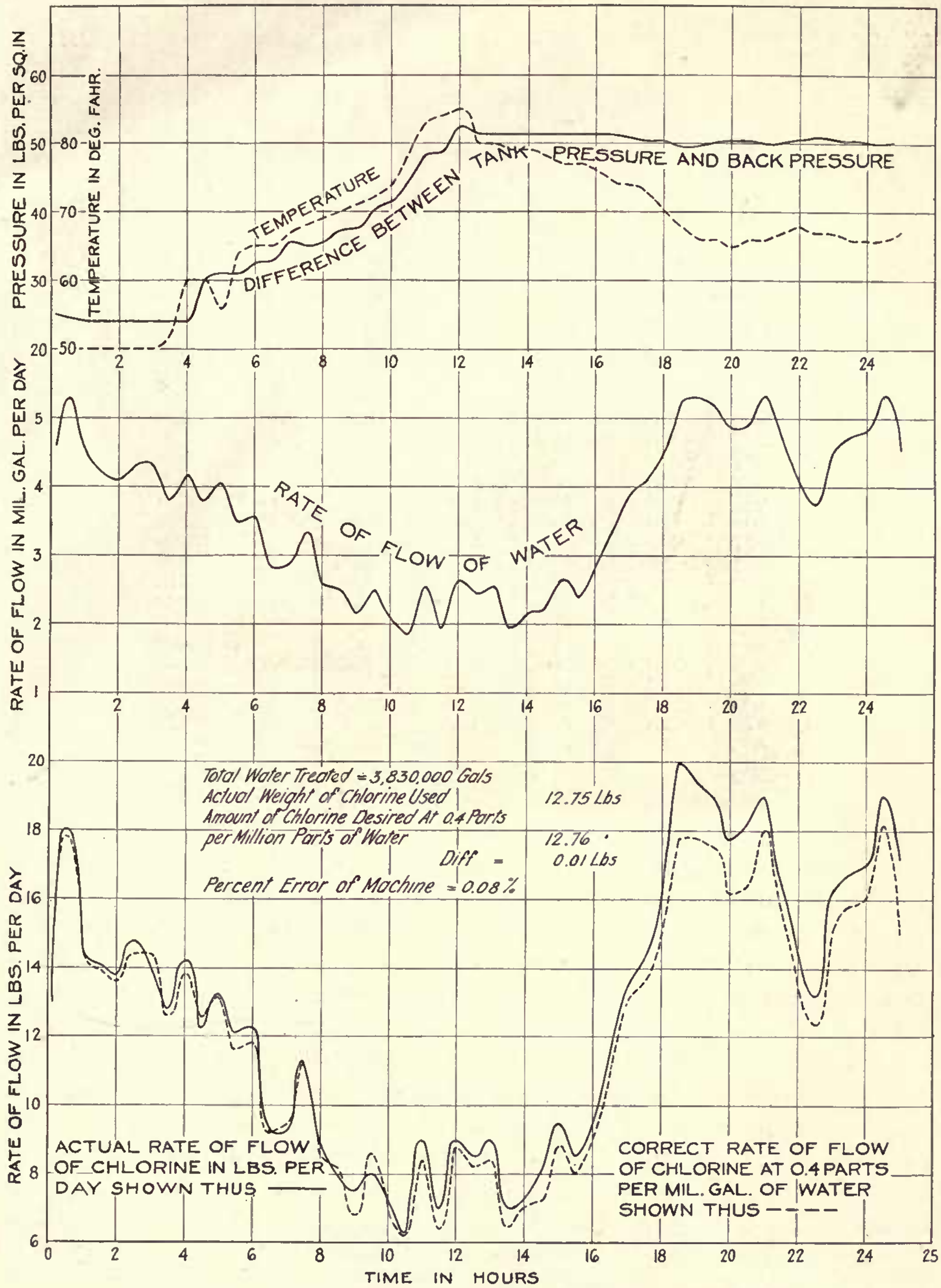
During May, 1913, the Stamford Water Company, Stamford, Conn., installed an automatic direct feed chlorine control apparatus. From the very beginning the weights of chlorine actually used, determined by weighing the chlorine cylinders daily on a set of scales, and the amount of chlorine



desired checked within 5%. Readings taken on the chlorine meter and on the venturi meter showed that the apparatus was working properly and neither overdosing with chlorine on low water flows nor underdosing on high water flows. There was never any lag in the dosing. In fact, the chlorine apparatus was quicker to respond to changes in water flow than the venturi meter.

On March 31, 1915, nearly two years after the apparatus had been in constant operation, the water company ran a twenty-four-hour efficiency test on the apparatus. The data resulting from this test are shown in the following chart and table. It is believed that the results speak for themselves. Attention is particularly directed to the fact that the apparatus accurately controlled the flow of chlorine regardless of varying temperature and varying pressure in the chlorine cylinders.

The temperature in the chlorine house was intentionally raised from 50° F. to 85° F. to determine this very question. With the change in temperature, the pressure in the chlorine cylinders went from 40 lbs. to 67 lbs.,



EFFICIENCY TEST ON CHLORINE APPARATUS
AUTOMATIC CONTROL

MADE MARCH 31, 1915 - BY STAMFORD WATER CO. - STAMFORD CONN.

EFFICIENCY TEST AT AUTOMATIC CHLORINE PLANT, STAMFORD, CONNECTICUT

MARCH 31—APRIL 1, 1915

TIME	CHLORINE					Room Temperature Degrees F.	WATER	
	Flow Meter lbs. per 24 hrs.	Correct flow lbs. per 24 hrs.	Tank Pressure lbs.	Back Pressure lbs.	Weight lbs.		Flow Million gals. per 24 hrs.	Venturi Register
P. M. 2:10	15.0	15.4	40	15	268.75	50	4.60	232855
2:30	18.0	17.8	40	15.5		50	5.30	
3:00	14.6	15.0	39	15		50	4.50	232872
3:30	14.1	14.0	39	15		50	4.20	
4:00	13.8	13.6	39	15		50	4.10	232882
4:30	14.3	14.4	39	15	267.25	50	4.30	
5:00	14.0	14.4	39	15		50	4.32	232909
5:30	12.8	12.6	39	15		52	3.80	
6:00	14.2	13.8	39	15	†266.0	60	4.15	232926
6:30	12.2	12.6	45	15	317.25	60	3.80	
7:00	13.2	13.2	46	15		56	4.05	232942
7:30	12.1	11.6	46	15		64	3.50	
8:00	12.2	11.8	47	15		65	3.58	232956
8:30	9.2	9.2	47	14.5		65	2.82	
9:00	9.2	9.4	50	14.5	316.0	67	2.85	232969
9:30	11.2	11.2	50	15		68	3.35	
10:00	9.0	8.6	50	14.5		69	2.60	232982
10:30	8.0	8.2	52	14.5		70	2.50	
11:00	7.5	6.8	52	14.5	315.0	71	2.15	232994
11:30	8.0	8.6	55	14.5		72	2.60	
12:00	7.2	7.0	56	14.5		74	2.10	232005
12:30	6.2	6.2	59	14.6		78	1.87	
A. M. 1:00	9.0	8.4	63	14.5		83	2.55	233014
1:30	7.0	6.4	63	14.2	314.25	84	1.92	233019
2:00	9.0	8.8	67	14.5		85	2.62	
2:30	8.5	8.2	66	14.5		80	2.45	233029
3:00	9.0	8.4	66	14.5	313.50	80	2.55	
3:30	7.0	6.4	66	14.5		79	1.95	233038
4:00	7.2	7.0	66	14.5		79	2.15	
4:30	8.0	7.2	66	14.5		78	2.20	233048
5:00	9.5	8.8	66	14.5		77	2.65	
5:30	8.5	8.0	66	14.5	313.00	77	2.40	233058
6:00	9.2	9.2	66	14.7		76	2.80	233064
6:30	11.5	11.0	66	14.7		74	3.35	
7:00	13.5	13.0	66	15		74	3.90	233079
7:30	14.2	13.6	66	15.5		73	4.10	
8:00	16.0	15.0	66	15.5		70	4.50	233099
8:30	20.0	17.8	66	16.2	311.00	68	5.25	
9:00	19.5	17.8	66	16.2		66	5.30	233120
9:30	19.0	17.6	66	15.7		66	5.20	
10:00	17.7	16.2	66	15.5		65	4.85	233140
10:30	16.2	16.4	66	15.5	309.50	66	4.90	
11:00	19.0	18.0	66	16.0		66	5.35	233161
11:30	16.5	15.6	66	15.7		67	4.70	
12:00	14.6	13.6	66	15.2		68	4.10	233180
12:30	13.2	12.4	66	15.0	308.50	67	4.75	
P. M. 1:00	16.2	15.0	66	15.5		67	4.55	233199
1:30	16.7	15.8	66	15.5		66	4.75	
2:00	17.0	16.0	66	15.7		66	4.80	233221
2:30	19.0	18.2	66	16.0	307.00	66	5.35	
3:00	16.9	15.0	66	15.5	306.50	67	4.50	233238

†New tank of chlorine attached

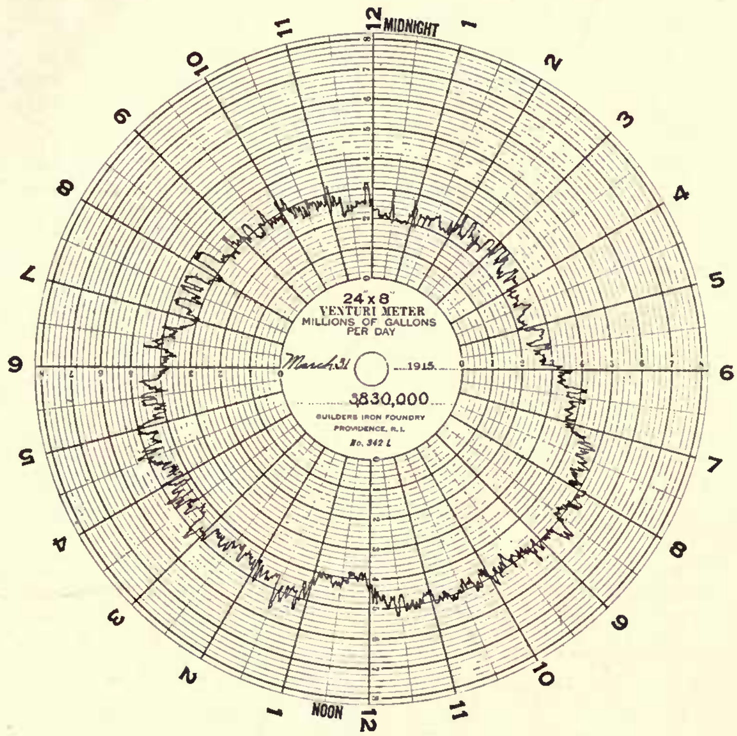
SUMMARY

Water treated	3,830,000 gals.
Actual weight of chlorine used	12.75 lbs.
Amount of chlorine desired at .4 parts per million parts water	12.76 lbs.

which made the effective pressure, or the difference between the tank pressure and back pressure, vary from 25 lbs. to 52.5 lbs.—a difference of over 100%.

The variations in the water flows were very sharp, as shown in the venturi curve, which is an exact reproduction of the water flow curve for the time the test was run.

For the opinion of the water company on the apparatus, reference is made to the letter of Mr. Hatch, manager of the Stamford Water Company, printed on page 34.



REPORTS OF EXPERIENCE

NEW HAVEN WATER COMPANY,
NEW HAVEN, CONN.

April 27, 1915.

Wallace & Tiernan Co., Inc.
Gentlemen:

In February, 1914, we installed an automatic chlorine sterilizer controlled by a 30 x 10″ Venturi meter tube treating a flow of from 7 to 12 million gallons per day. At this time we had much construction work being carried on above the Reservoir, and regarded the installation of this apparatus as very essential in safeguarding our supply from the possibility of pollution from this source.

Since that time the apparatus has been in constant use. For about five weeks we kept a daily analysis of the results, and later a weekly analysis of both the treated and untreated water. We have removed from 85% to 90% of bacteria, and have had no coli present in the water after treatment. The rate varies from .1 to .4 parts per million, and has cost us during the year an average of 20 cents per million gallons. No additional labor has been required. An inspection of the machine is made daily and its operation has been entirely satisfactory. Small mechanical troubles have developed, as is likely in any new machine, but these have been remedied by your Company, so that the operation of the machine has given us but very little trouble. In 1914 we treated 2½ billion gallons of water.

We consider the apparatus to greatly increase the safety of our supply, and take pleasure in offering you this testimonial.

NEW HAVEN WATER COMPANY,
EDWARD MINOR, *Superintendent.*

STAMFORD WATER COMPANY,
571 MAIN STREET,
STAMFORD, CONN.

April 18, 1915

Wallace & Tiernan Co., Inc.
Dear Sirs:

Your letter of the 8th received. I am glad to report that your automatic chlorine gas machine operated from a venturi tube has given us very good service. It has now been in use over a year, and at times has run as long as six months without any adjustments.

We find it a great saving over hypochlorite treatment, as we can treat the water with gas at a cost per million gallons of from twenty-five to fifty cents, according to the amount of gas used and have no trouble with governing the amount of gas used. We consider that there is no comparison between hypochlorite and chlorine gas, as the gas is so far ahead of the hypochlorite solution. With the gas you have a known amount of chlorine, and with the lime it is unknown, as the lime varies in strength, and if the lime is not properly mixed every time a new tank is made up, you do not get the same amount of chlorine out of the lime. You also have trouble with the sludge left over from the lime, which makes the labor cost very high and keeps the plant very dirty, while with the gas everything is clean unless you get some leaks.

Your apparatus is certainly a wonderful little machine and controls the gas at any flow.

EDWARD L. HATCH, *General Manager.*

WASHINGTON COUNTY WATER COMPANY,
HAGERSTOWN, MD.

July 22, 1914.

Wallace & Tiernan Co., Inc.
Gentlemen:

We are very much pleased with the liquid chlorine plant installed by you at our reservoir in the Mountain.

We have been using it for about two months, and have found its operation simple and accurate, and results in treatment of water very satisfactory.

You certainly have designed a simple apparatus, easily understood and handled by the layman with good results.

WASHINGTON COUNTY WATER CO.
ALBERT HEARD, *General Manager.*

JOHN F. MEYER & SONS MILLING CO.,
SPRINGFIELD, MO.

April 22, 1915

Wallace & Tiernan Co., Inc.

Gentlemen:

We have been using your apparatus for the control of chlorine for several months past and we do not hesitate in saying that it does everything you claim for it, namely, it positively and accurately controls the flow of chlorine. It has given us entire satisfaction.

JOHN F. MEYER & SONS MILLING CO.

THE TORRINGTON WATER COMPANY,
TORRINGTON, CONN.

December 17, 1914

Wallace & Tiernan Co., Inc.

Dear Sirs:

The chlorine device appears to be working perfectly.

Please quote on two more, same type.

THE TORRINGTON WATER COMPANY.
F. M. TRAVIS, *Superintendent.*

NEW BRUNSWICK, N. J.

July 20, 1914

Wallace & Tiernan Co., Inc.

Gentlemen:

Just a line to say that the liquid chlorine apparatus that was installed by you at our Pumping Station at New Brunswick, N. J., for treating the water with liquid chlorine is very satisfactory.

The apparatus is working finely, and we are not having any trouble with the same.

FERD. W. STAHLIN, *Superintendent.*

AMERICAN WATER WORKS & ELECTRIC CO.,
50 BROAD STREET,
NEW YORK CITY.

April 20, 1915

Wallace & Tiernan Co., Inc.

Gentlemen:

We are pleased to say that the three pieces of manually operated apparatus for feeding chlorine gas, purchased from you, are now in successful operation. The first of these installations was made about six months ago. We have no reason to criticize the bacterial efficiency obtained by the apparatus, and there have been no complaints on account of taste in the water.

AMERICAN WATER WORKS & ELECTRIC CO.,
GEORGE W. BIGGS, JR., *Chief Engineer.*

THE SCRANTON GAS & WATER CO.
SCRANTON, PA.

April 28, 1915.

Wallace & Tiernan Co., Inc.

Gentlemen:

We have one of your chlorine machines now which has been in service a year, and two others for shorter periods of time. All are giving excellent satisfaction. The machines feed with surprising accuracy and constancy, one of them being now in its sixtieth month of continuous running without having been touched other than for the replacement of empty chlorine cylinders. We find the liquid chlorine treatment a great improvement in every way over the hypochlorite method. So far, in our experience with the Wallace & Tiernan machine we have had less trouble than we have in our hypochlorite plants with blocked and corroded pipes.

We are so well satisfied that we are adding three more machines this spring.

SCRANTON GAS & WATER CO.
GEORGE R. TAYLOR, *Chemist.*

TYPHOID AND THE CHLORINATION OF THE WATER SUPPLY

[Translation from the *Periodico Diario de la Marina*, Havana, December 11, 1914]

Dr. Guiteras, the Director of Sanitation, has reported upon the results accomplished by Dr. Libredo at the Palatino Reservoir, as shown by bacteriological tests of the Vento water supply. A great diminution in microbes is demonstrated to have taken place since the inauguration of purification by liquid chlorine.

The Vento water was tested by cultivation in Petri dishes, colonies of bacteria in one cubic centimeter being counted as follows:

Before chlorination:

Colonies in 1 cc.	
24 hours	400
48 hours	600
72 hours	600
96 hours	600

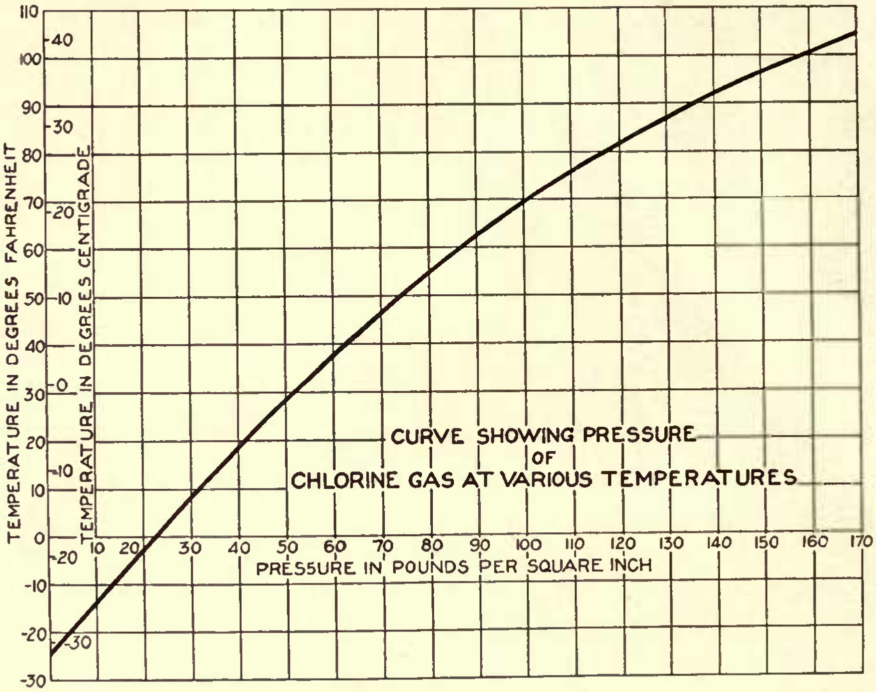
After chlorination:

Colonies in 1 cc.	
24 hours	10
48 hours	12
72 hours	24
96 hours	44

These figures show that the purification by liquid chlorine is giving satisfactory results. There is also a decrease in the incidence of typhoid fever, of which but one hundred cases now exist in Havana.

CHLORINE DATA

Chlorine [χλωρος = green] a greenish yellow gas, easily compressed to a liquid, was discovered in 1774 by Scheele, a Swedish Chemist. Atomic weight 35.45, Molecular weight 70.9, Vapor density 35.8, Liquifies at −33.6° C (−28.5° F), Solidifies at −102° C (−151.36° F). Under pressure of 6 atmospheres liquifies at 0° C (32° F).



WEIGHTS OF CHLORINE

Datum	Gaseous Chlorine	Liquid Chlorine
Specific gravity	2.49 (Air = 1)	1.44 (Water = 1)
Weight of 1 liter	3.167 grams	1440 grams
Weight of 1 cubic foot	0.198 pounds	89.752 pounds
Weight of 1 gallon	0.026 pounds	11.999 pounds

One volume of liquid chlorine is equivalent to 444.4 volumes of chlorine gas.

SOLUBILITY OF CHLORINE

Temperature		Solubility Ratio by Volume	Pounds of Chlorine Soluble in One Million Gallons of Water
C°	F°		
0	32	1.5	20,000
10	50	3.0	40,000
30	88	1.8	24,000

One part per million = 8.34 pounds per million gallons of water = 0.058 grains per gallon. One grain per gallon = 17.12 parts per million = 142.86 pounds per million gallons of water.