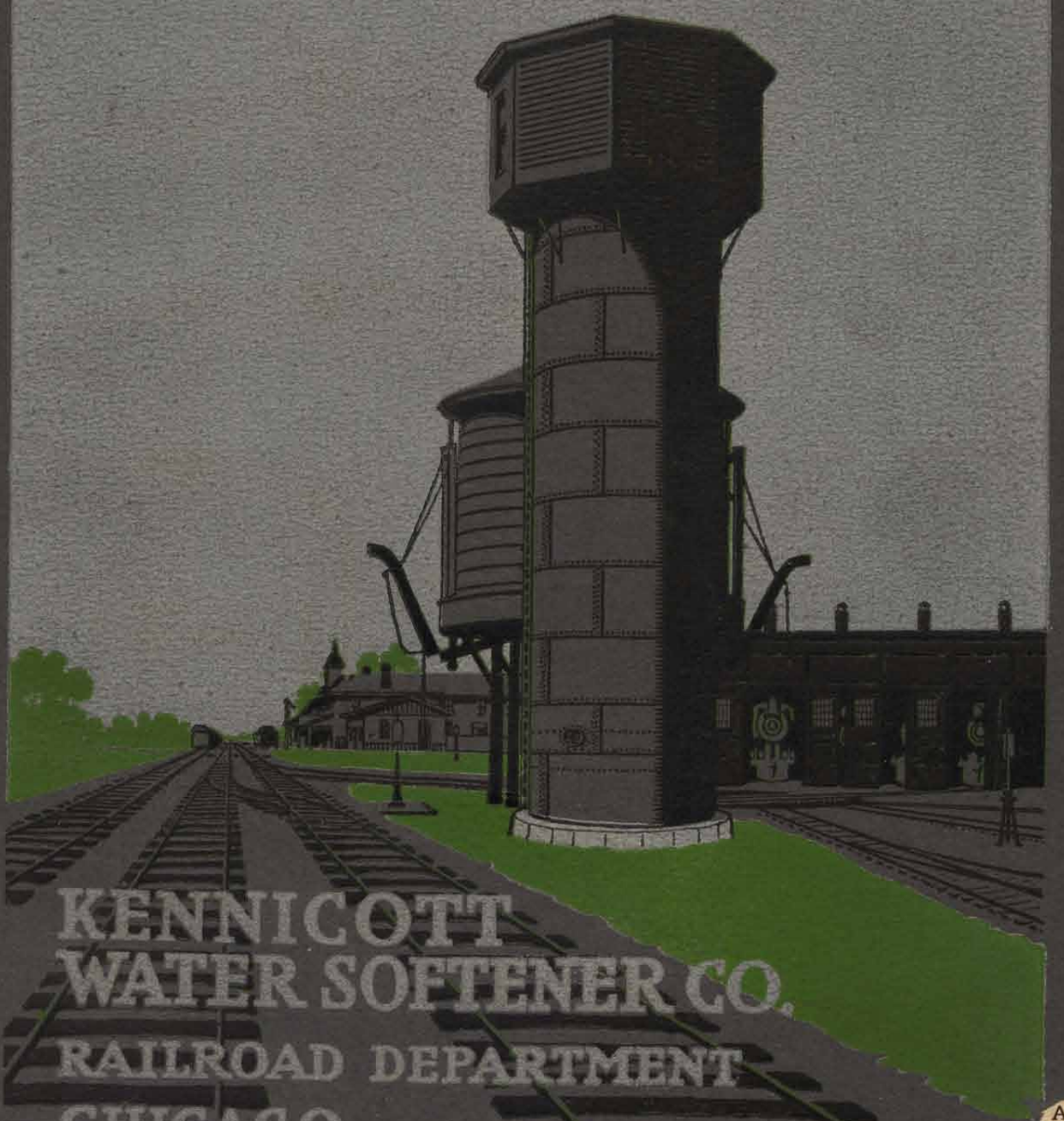
SOFT WATER



KENNICOTT
WATER SOFTENER CO.
RAILROAD DEPARTMENT
CHICAGO.

A

SOFT WATER

HOW TO OBTAIN IT FOR RAILROADS & INDUSTRIAL PURPOSES

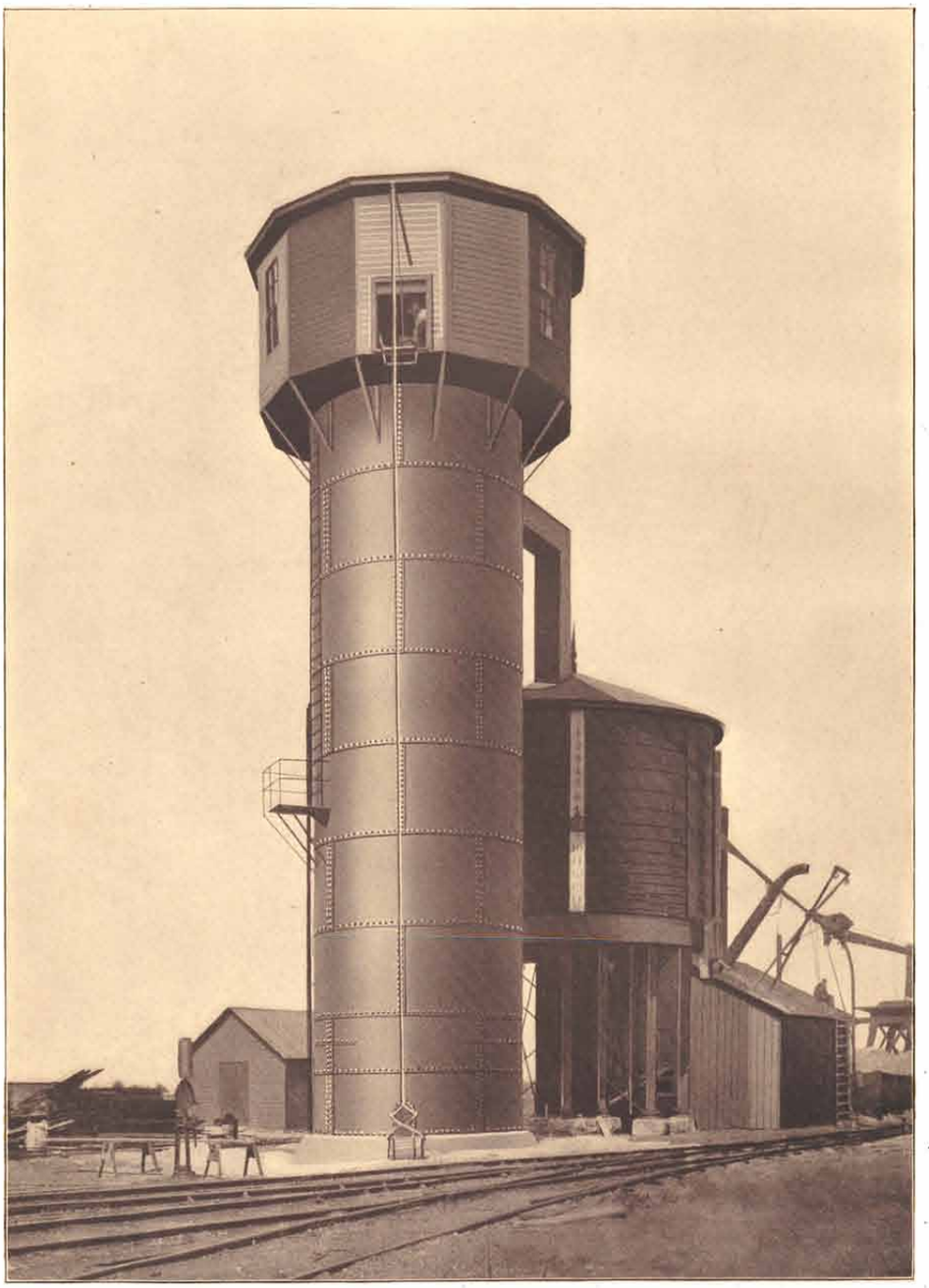
Chauncey J. Blair, Pres. Cass L. Kennicott, Vice-Pres. & Gen. Mgr. Walter H. Green, Sec. John Benham, Treas

Kennicott Water Softener Company

Sole Owners of the Kennicott Patents

Works and Laboratories 35th and Butler Streets

W. R. Toppan, Manager Railroad Department, 77 Jackson Boulevard, Chicago, U. S. A



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Council Bluffs, Iowa.

One of thirty-six Kennicott Softeners upon the Union Pacific Railroad. Capacity, 15,000 gallons the hour.

Foreword

THE subject of softening water for industrial purposes has received but little attention in years gone by, although methods for treating hard water were discovered half a century ago.

Manufacturing plants have usually been located with a view to the supply of labor, cheapness of fuel, and accessibility to markets—the quality of the water to be used being a secondary consideration. Of necessity railroads have located their watering stations where there was an abundance of water, without regard to its quality.

More recently, however, the keen competition of new industrial conditions and the necessity of reducing the cost of operation to the minimum, have led progressive managers to appreciate the immense saving that can be effected by having a soft water for use in boilers and for other purposes.

It is the purpose of this book to explain the most effective and economical method of transforming a hard water into a soft water, and to show those interested the very material saving that can be effected by properly softening and purifying water before it is used.

KENNICOTT WATER SOFTENER

PITTSBURG & LAKE ERIE RAILROAD. Railroad Shops, McKees Rocks, Penn.

Capacity, 1,000 gallons per minute or 60,000 gallons the hour. Treats well water, delivering the softened water to two 500,000-gallon steel storage tanks, shown on either side of Water Softener. Cost of treatment, three cents per 1,000 gallons.

Water—Its Elements

WATER is the chemical combination of two parts hydrogen with one part of oxygen.

Water is familiar to us in three forms: (a) the solid—as ice; (b) the liquid—as water; (c) the gaseous—as steam.

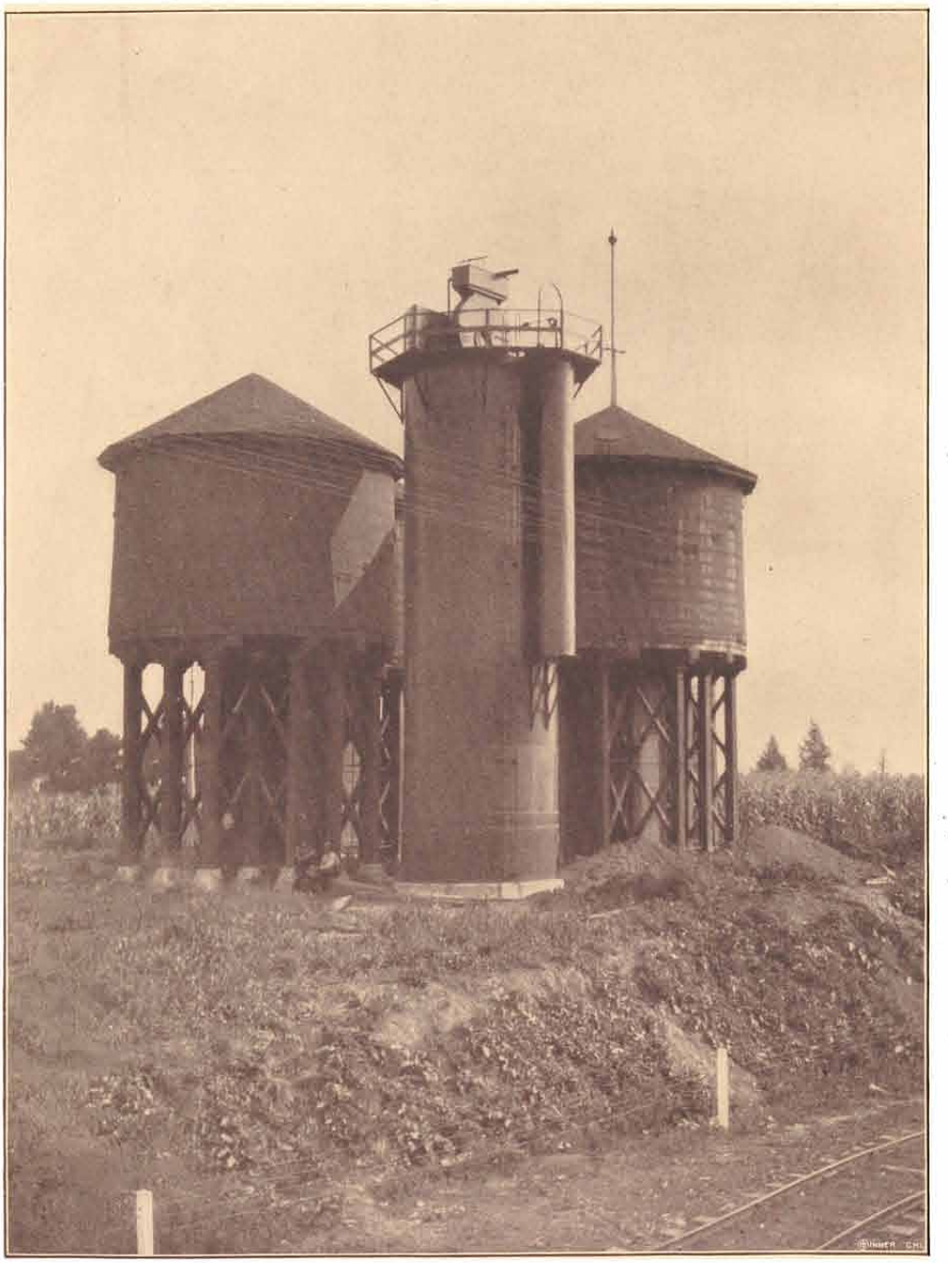
Ninety-nine per cent of the earth's water is in the oceans. The atmosphere is constantly charged with water, in the form of vapor, that has evaporated from the oceans, lakes, rivers, etc.

Cool currents of air condense this vapor, and it falls again to the earth in rain, snow, or hail.

Vapor so condensed forms what is commonly known as *Soft Water,* or rain water.

As this water filters through the ground it dissolves certain chemical properties, and absorbs certain impurities.

When rain falls in a region abounding in limestone, for example, as the water passes through the ground it quickly dissolves the lime or magnesia, and becomes *hard* water.



KENNICOTT WATER SOFTENER

CHICAGO, BURLINGTON & QUINCY RAILWAY CO. Buda, Illinois.

A creek and spring water, pumped from creek, one and one-quarter miles distant. Capacity, 10,000 gallons the hour. Cost of operation (for chemicals) one and one-half cents for each 1,000 gallons. 588 pounds of incrusting solids removed each day. Nine tons of incrusting solids removed each month. This Softener supplies three large storage tanks.

Water Its Impurities

WATER is a solvent—that is, it will absorb solids, gases and other liquids. It will actually absorb its own bulk of some other chemical agents. Thus it acquires almost endless impurities as it passes through the ground.

The mineral impurities particularly objectionable when water is to be used in boilers for making steam, are:

Carbonates and sulphates of magnesia and lime, oxides of iron and alumina, silica, matter in suspension such as mud and sand, and organic matter—these all form boiler scale.

Carbonic acid, organic matter, and magnesium chloride and sulphate, cause boilers to corrode or pit.

Alkalies, sodium carbonate and organic matter cause what is termed "priming" or "foaming."

To secure the best and most economical results from water to be transformed into steam, it must be *softened*—that is, freed from scale-forming impurities.

KENNICOTT WATER SOFTENER

ATCHISON, TOPEKA & SANTA FE RAILROAD. Crozier, Arizona

Capacity, 10,000 gallons the hour. Automatically treats two waters showing different analyses, one at a time or both at one time. Cost of treatment one and eight-tenths cents per 1,000 gallons.

Soft Water vs. Hard Water

WHEN hard water is evaporated in a boiler the incrusting impurities are deposited upon the inside of the boiler or on the boiler tubes in the form of scale.

One-sixteenth of an inch of this scale on the inside of a boiler necessitates the consumption of twelve per cent more fuel to generate the same amount of steam; one-quarter of an inch of scale requires thirty-eight per cent more fuel; while three-quarters of an inch of scale causes a loss of ninety per cent of fuel.

The accumulation of this scale not only increases the cost of fuel, but by placing insulation between the boiler and the water allows the sheets and flues to become overheated, subjecting them to extremes of expansion and contraction. Then, too, it is frequently necessary to shut down the boiler to remove the scale.

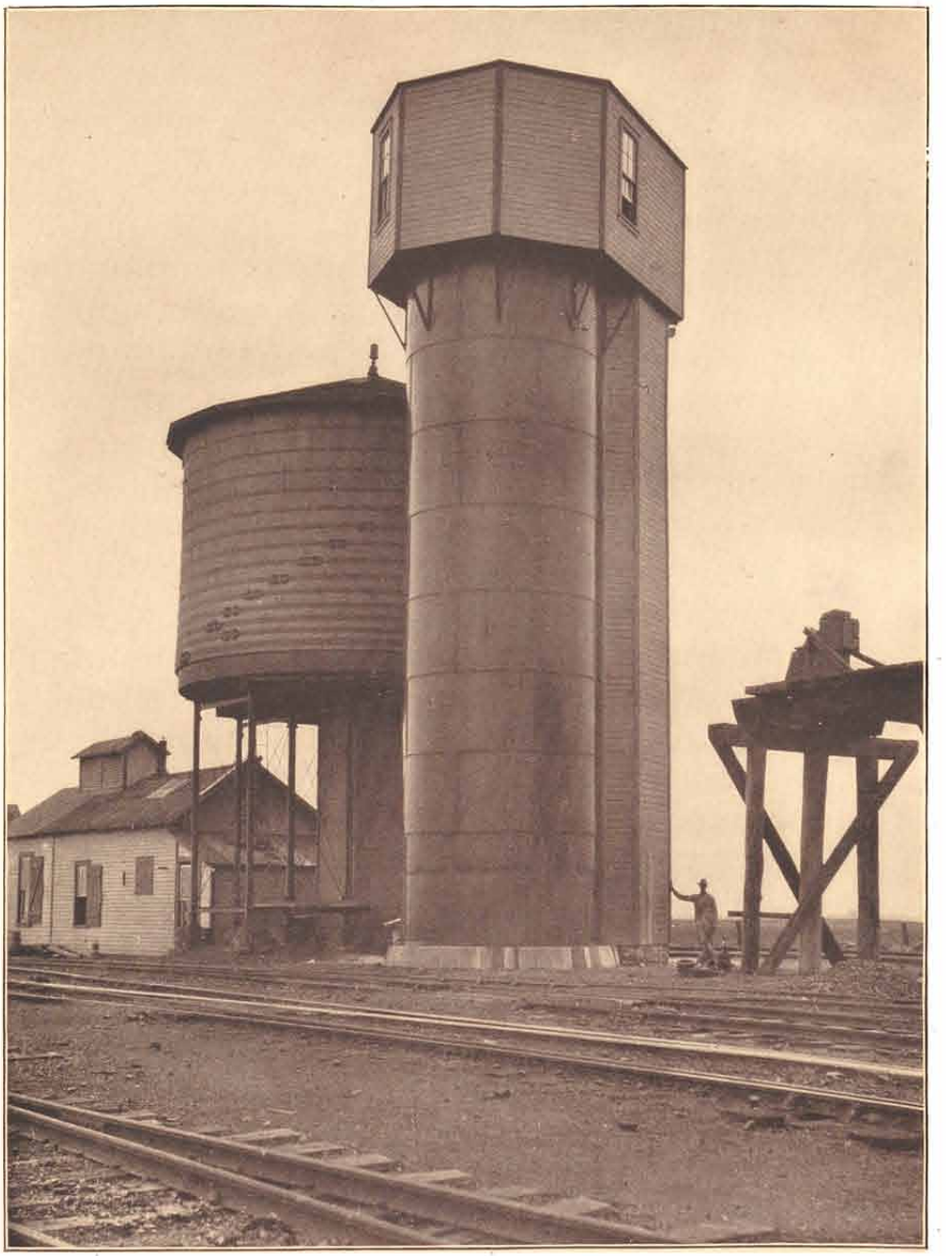
The corrosive salts, such as magnesium chloride in hard water, cause the structure of the boiler itself to corrode—thus shortening its life.

Softened water is water freed from salts of lime and magnesia, iron and aluminia.

It cannot deposit scale; it cannot corrode.

Water can be softened in *unlimited quantities at nominal cost.*

Its use saves coal bills, repair bills, shutdowns. It lengthens the life of the boiler and increases its efficiency.



KENNICOTT WATER SOFTENER

CHICAGO & EASTERN ILLINOIS RAILROAD. Rossville Junction, Illinois.

Daily softening capacity, 168,000 gallons. Over five tons of scale-forming solids removed monthly. Cost of treatment, one and one-tenth cents per 1,000 gallons.

Softening and Purifying Water

HARD WATER contains various salts or minerals in soluble or suspended form which cause corrosion or the formation of scale in boilers when steam is generated.

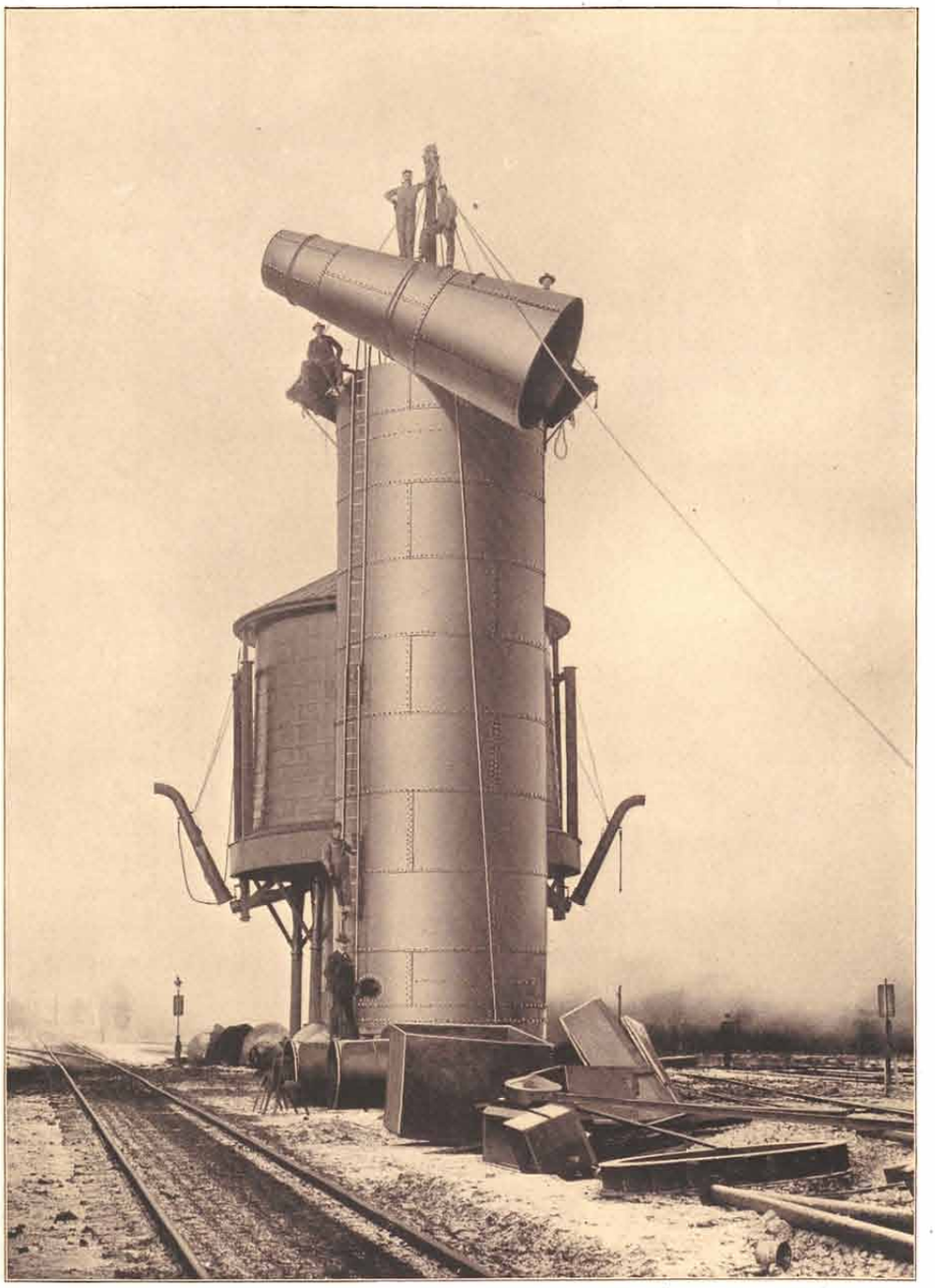
A water softening machine, or a Water Softener, is an apparatus that *removes* these scale-forming or corroding agents *before the water goes into the boiler.*

Sixty years ago the process of treating water with lime to remove carbonic acid and carbonates of lime and magnesia was invented by Dr. Clark, an English chemist.

Shortly thereafter the process of removing sulphates of lime and magnesia by means of soda ash was invented by Dr. Porter. A combination of these two methods is called the Porter-Clark process—an excellent idea, as far as it goes.

Next came the crude settling tanks—expensive to operate owing to the necessity for repumping the water, which doubles the cost of treatment — unsatisfactory in results because of the crudeness of the method and the lack of any device for varying the amount of materials in proportion to the quantity of the water treated.

The Kennicott Water Softener is an apparatus constructed on scientific principles, and protected by numerous patents, for softening and purifying water at *absolutely the lowest possible cost.*

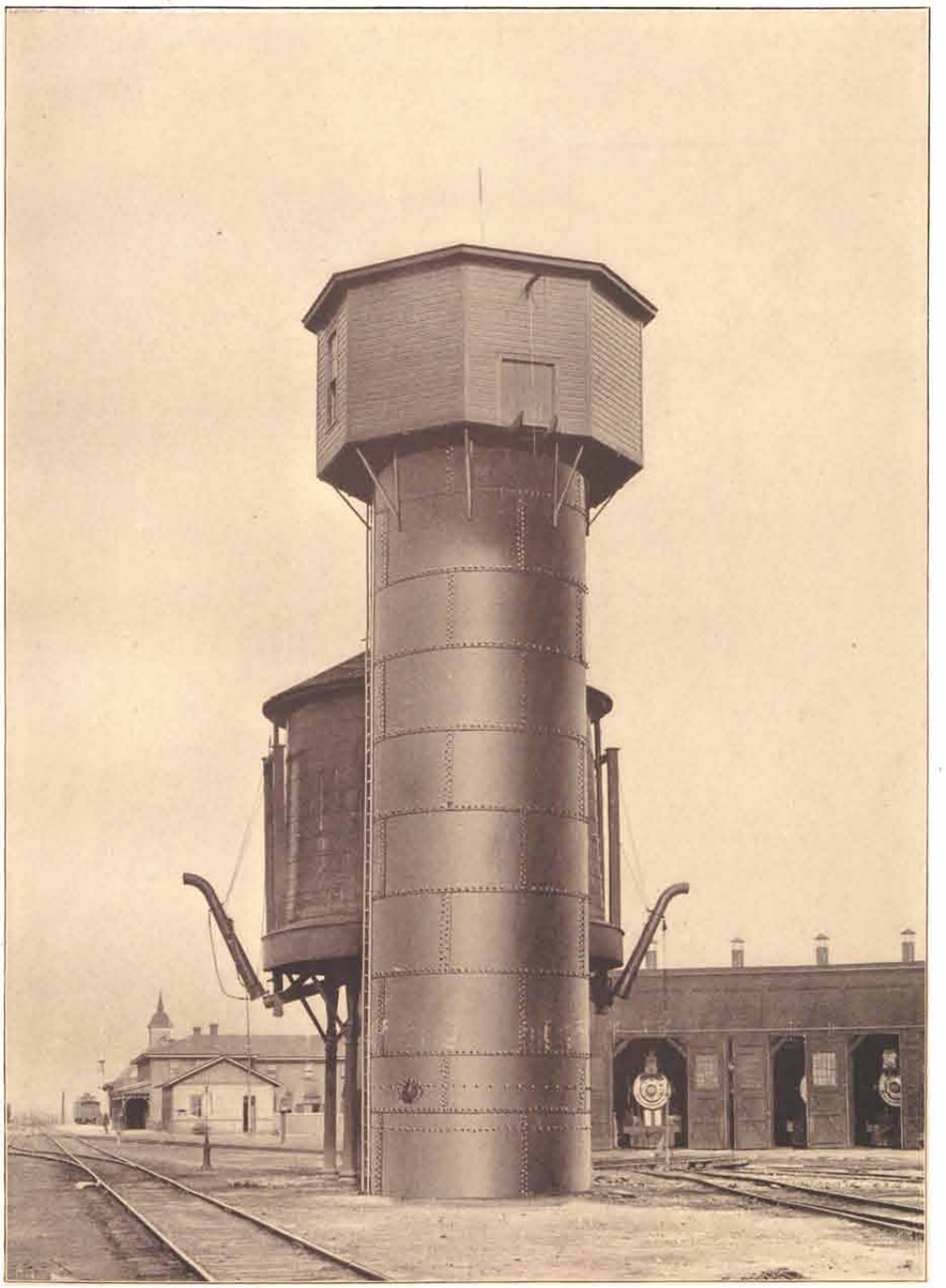


KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Sidney, Neb.

Showing Softener under construction. Capacity, 10,000 gallons the hour.

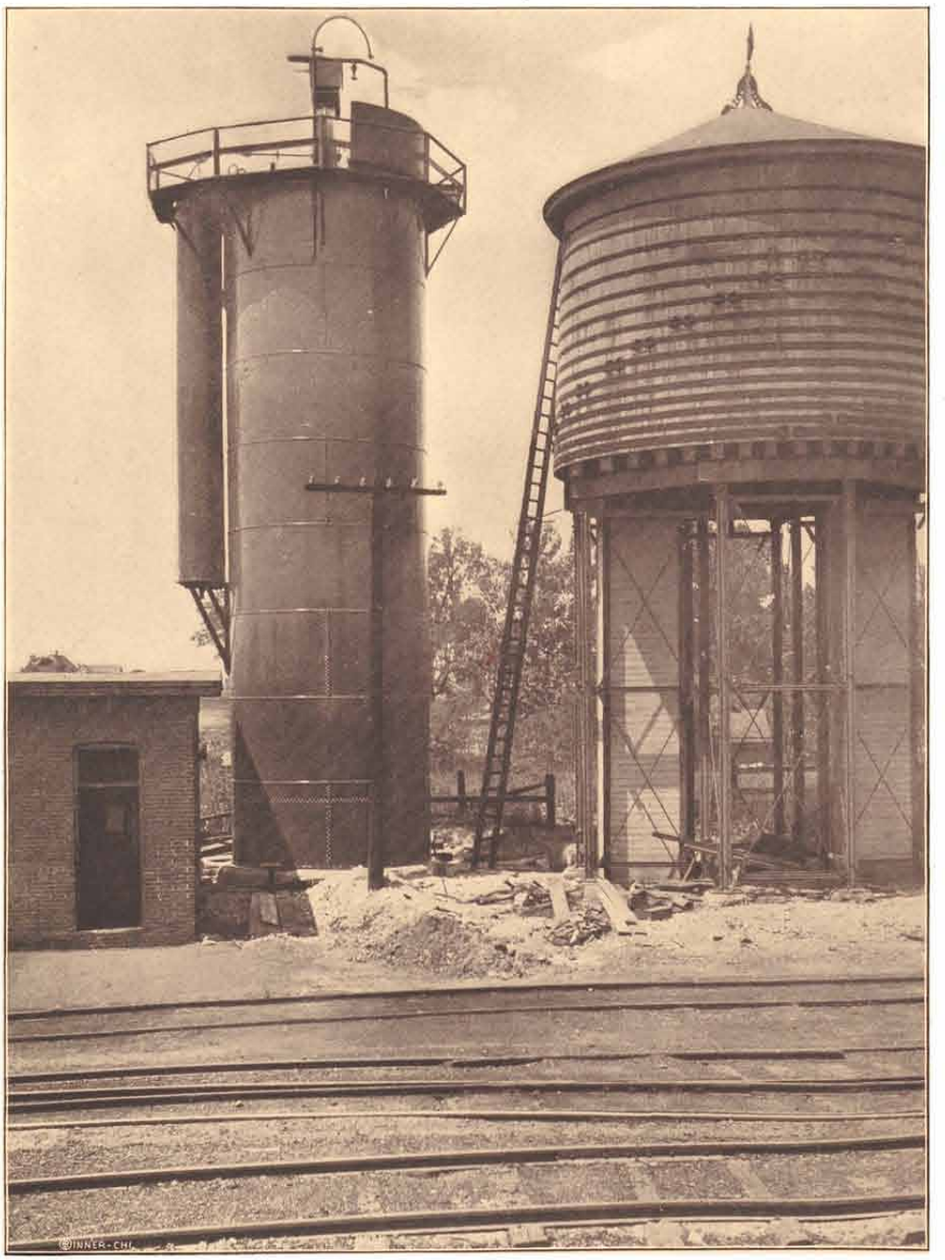
KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Sidney, Neb.

Surface well water. Capacity, 10,000 gallons the hour. Cost of treating, one and one-half cents for each 1,000 gallons.



KENNICOTT WATER SOFTENER

WABASH RAILROAD
Peru, Indiana.

Daily softening capacity, 192,000 gallons. Removes over nine tons of scale-forming solids each month.

How to Get Soft Water

FIRST, analyze the water—find out what harmful impurities it contains. Then *remove* the impurities *before* the water goes into the boiler—don't try to do it after the water goes into the boiler.

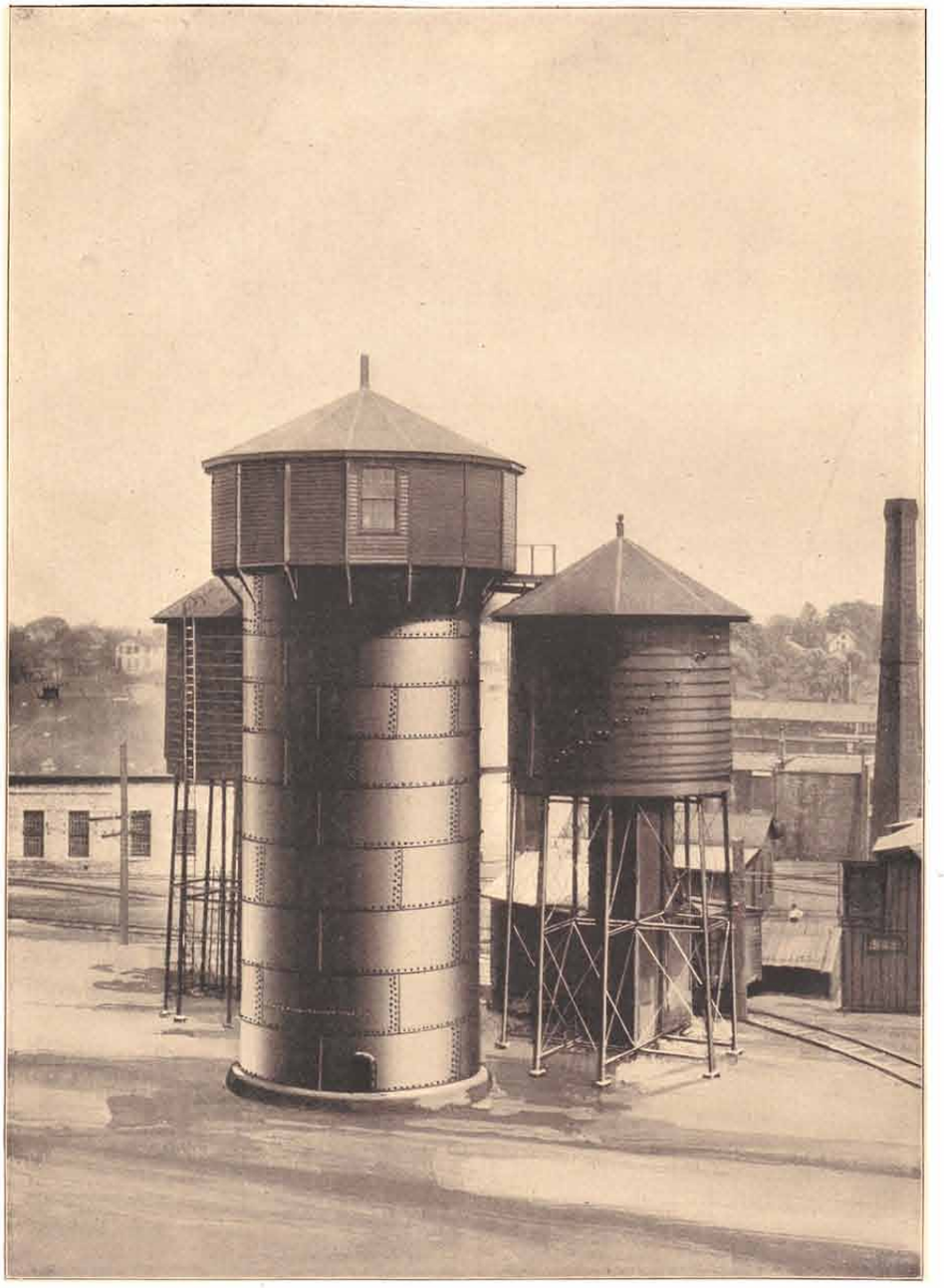
Practically all impurities which cause water to be hard are subject to the action of chemical reagents—that is, other chemicals that will cause them to precipitate in insoluble condition so they can be removed.

To do this successfully requires a properly constructed apparatus—one that will treat the water automatically—that will augment and supplement the work of the reagents.

Chemical analysis shows what reagents to use, while the practical experience gained by years of study and research, coupled with the marked success of the apparatus in actual use, demonstrates conclusively that the Kennicott Water Softener solves the problem of constructing a machine that mixes these reagents in exactly the right proportion to insure the precipitation of the harmful matter and then to remove it.

The idea is simple—the method is simple—the result is simple—just *soft water,* that won't scale, that won't corrode.

KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

CHICAGO, BURLINGTON & QUINCY RAILWAY CO. Aurora, Illinois

Softens river water for use in shops and locomotives. Capacity, 30,000 gallons the hour. Cost of treatment, two and one-half cents per 1,000 gallons.

Feed Water Heaters and Boiler Compounds

THE purpose of a heater, as its name implies, is to *heat* the water. To place any additional duty on this apparatus necessarily reduces the efficiency of its original purpose.

Any matter which is removed from the water as it passes through a heater, is deposited on its interior surface. This deposit cannot be drawn off at frequent intervals, and as it accumulates the efficiency of the heater is correspondingly reduced.

Frequently this precipitate re-dissolves and passes into the boiler, while the removal of the scale requires the shutting down of the heater and the laborious chipping out of the deposit.

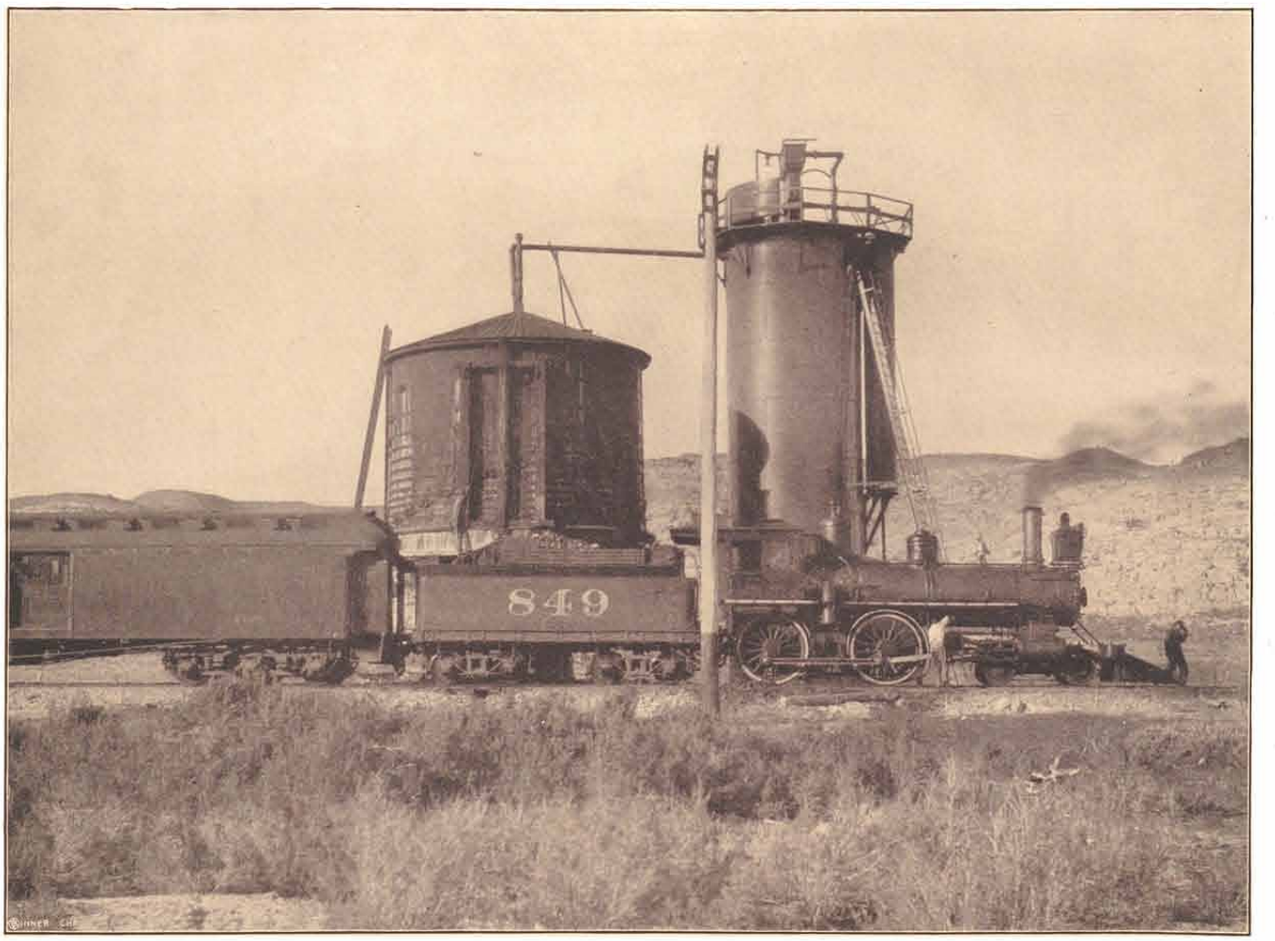
In installing a plant, the first requisite to economical operation is to get a good boiler.

And then get a Kennicott Water Softener to properly purify and soften the water *before* it goes into either heater or boiler. If exhaust steam is available it is usually desirable to save the heat contained by using it to heat the boiler feed water. Then a heater may be used either before or after the water is softened. If the heater is placed between the softener and the boiler, the heater will always operate at full efficiency, as it will not scale.

Boiler Compounds

There is a correct method, a proper place and a seasonable time for every chemical and mechanical operation. The chemistry of some boiler compounds is correct; that is, they precipitate the scale-forming material, but the time and place are wrong—in the boiler the heat will precipitate lime and magnesia, with or without a compound.

Water is no exception to the rule that a thing should be purified before it is used—not afterwards.



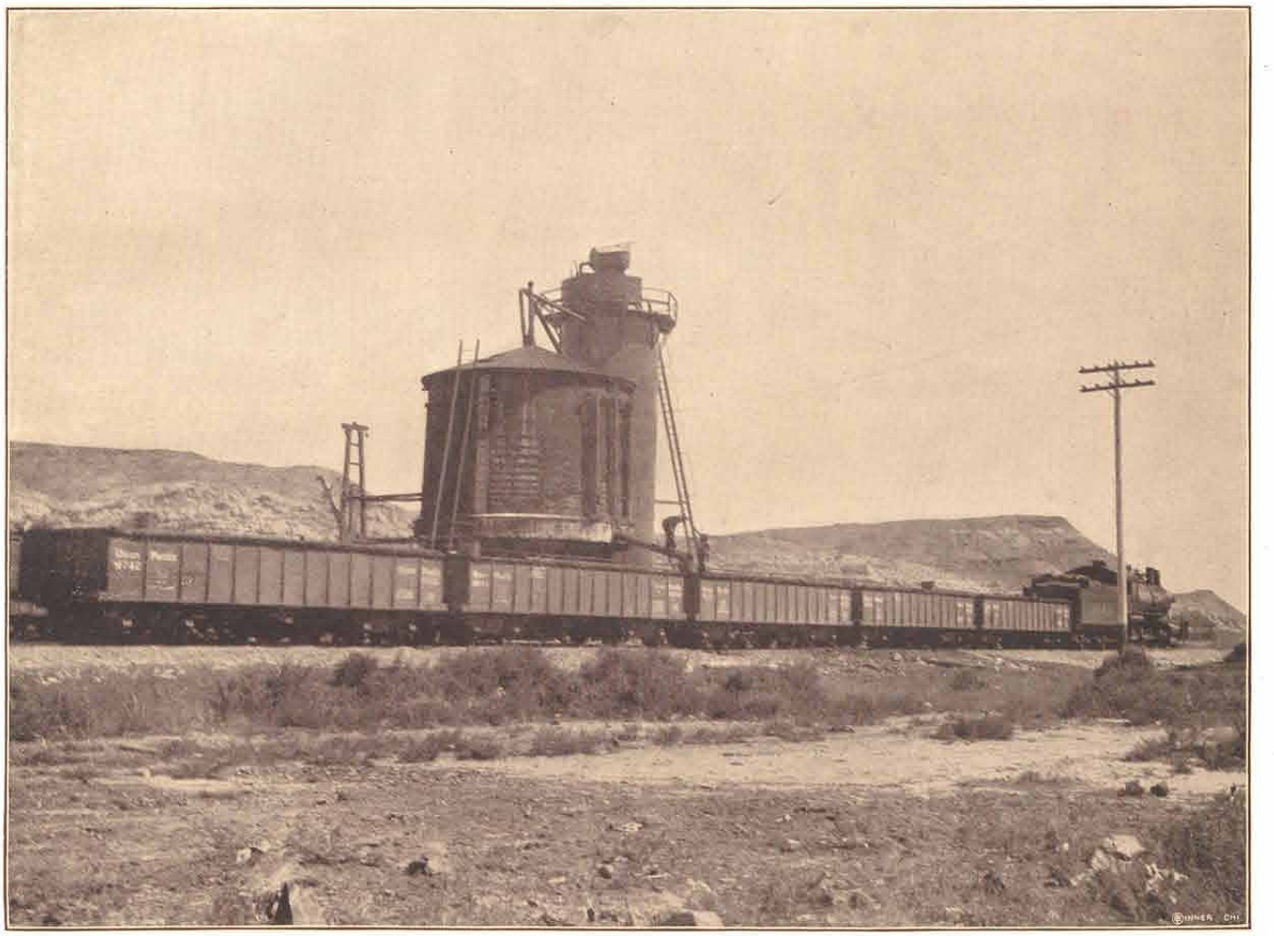
KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD

Point of Rocks, Wyo.

Artesian well water. Capacity, 8,000 gallons the hour. Cost of operation (for chemicals) one cent for each 1,000 gallons. 352 pounds of incrusting solids removed each day. Five tons of incrusting solids removed each month.

KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Wyoming Division.

From this Kennicott Softener soft water is hauled by water train to other water stations.

VIEWS IN THE KENNICOTT LABORATORIES

The Kennicott Laboratories

A CHEMICAL analysis of the water to be used in boilers is the first step towards its proper treatment to prevent scale formation, corrosion and foaming.

The Kennicott Laboratories have been established and equipped solely for the analyzing of waters. Neither money, time, nor labor is spared to secure absolutely accurate analyses.

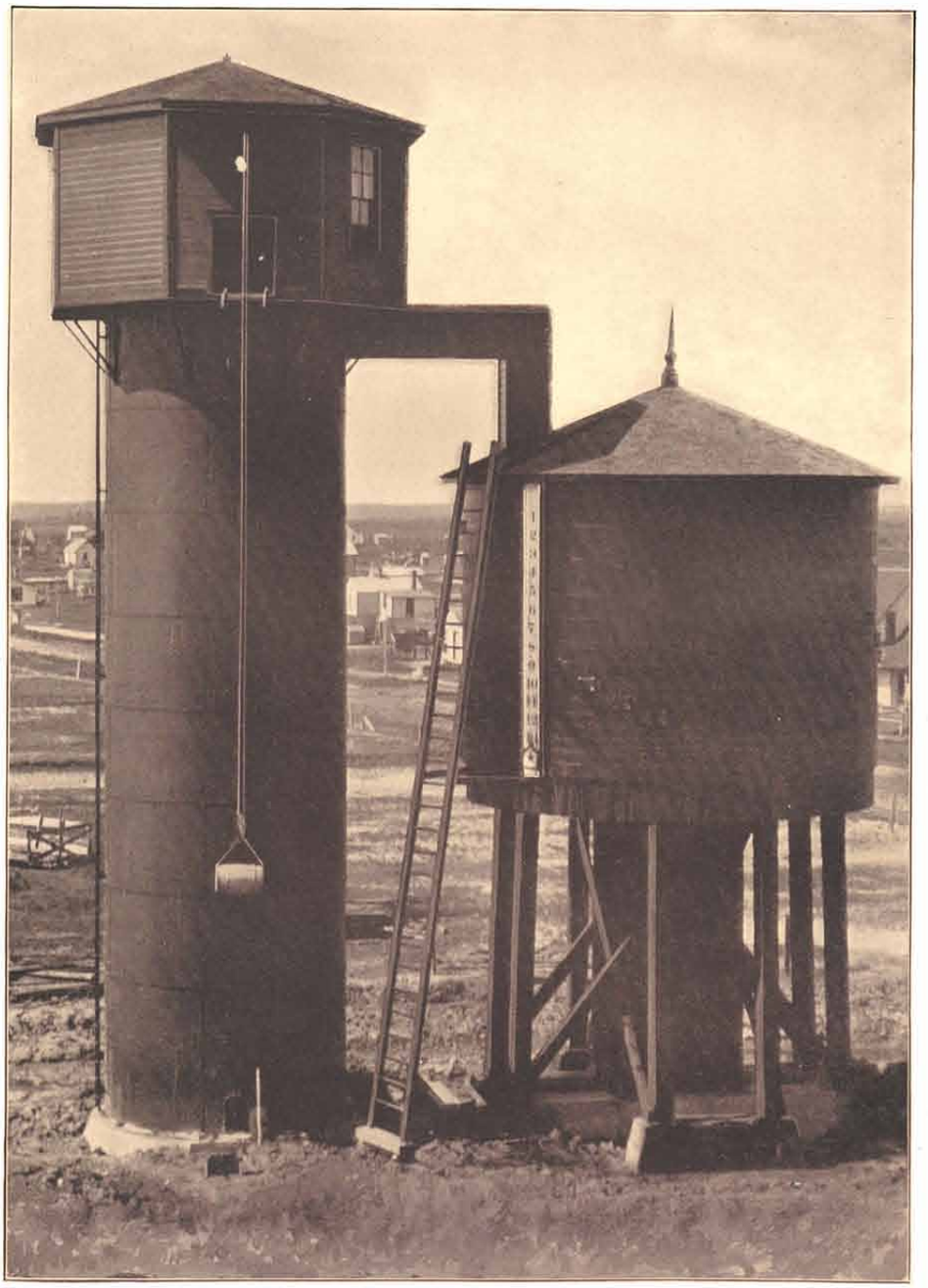
Two of the officials of the Company are practical chemists, and from six to ten additional chemists are constantly employed in these laboratories making careful analyses of waters.

As many as 289 samples of waters, from points in fifteen different States, have been received at the laboratories in a single month; and the actual work performed during the same period covered complete analyses of 213 of these samples.

The report of the examination of the water supply on one Railroad Division alone covers thirty-five closely typewritten pages. A reduced fac-simile of this report will be cheerfully furnished, on request, as an illustration of the value and efficiency of the work performed in the Kennicott Laboratories.

Analyses of any water supply will be made, absolutely free of charge, for any interested firm, company or corporation; and the necessary instructions for sending samples of water will be forwarded upon application.

Where a number of waters are to be analyzed and typewritten report made, a nominal charge will be made for same.



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Lexington, Neb.

Capacity, 10,000 gallons the hour. Cut shows barrel of lime being hoisted to top of softener by power of the water as it enters the machine.

Its Superiority

THE Kennicott System possesses many points of advantage over other methods of softening water:

Its construction is of the most stable character.

It requires but a single foundation and simple housing.

It does not require the repumping of the purified water into a storage tank, but delivers the water direct from the Softener by gravity.

The entire apparatus is inclosed in a single tank, thus preventing injury from freezing.

The chemical reagents are hoisted automatically to the top of the machine.

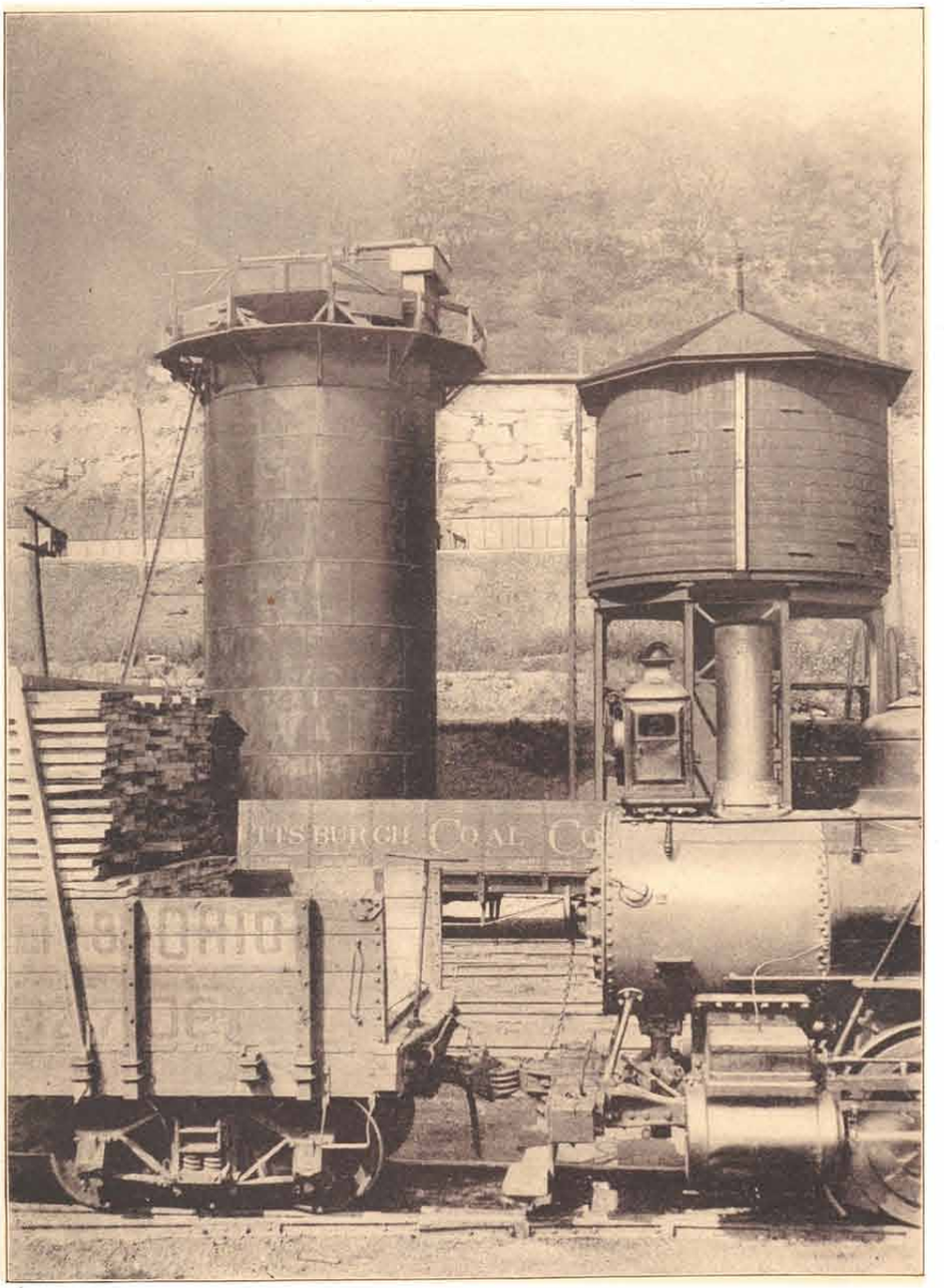
It uses purified water for dissolving the reagents.

It automatically varies the amount of materials according to the quantity of water entering the apparatus.

The minimum quantity of reagents is required.

Any one can operate it; it has no secret processes, no magic; everything is simple, plain, open, understandable.

And in addition to these features, every one of which has vital bearing on the combined efficiency of the Kennicott System, there is that indisputable fact—proved again and again by practical tests, under varying conditions—that the *cost of operation is far less* and the *ease of operation far greater* by the Kennicott System than by any other method of securing even approximately as satisfactory results.



KENNICOTT WATER SOFTENER

PITTSBURG & LAKE ERIE RAILROAD. Williamsburg, Penn.

Capacity, 21,000 gallons the hour. Treats water from the Monongahela River. The acid frequently contained in this water, which comes from coal mines and coke ovens, is removed by the process.

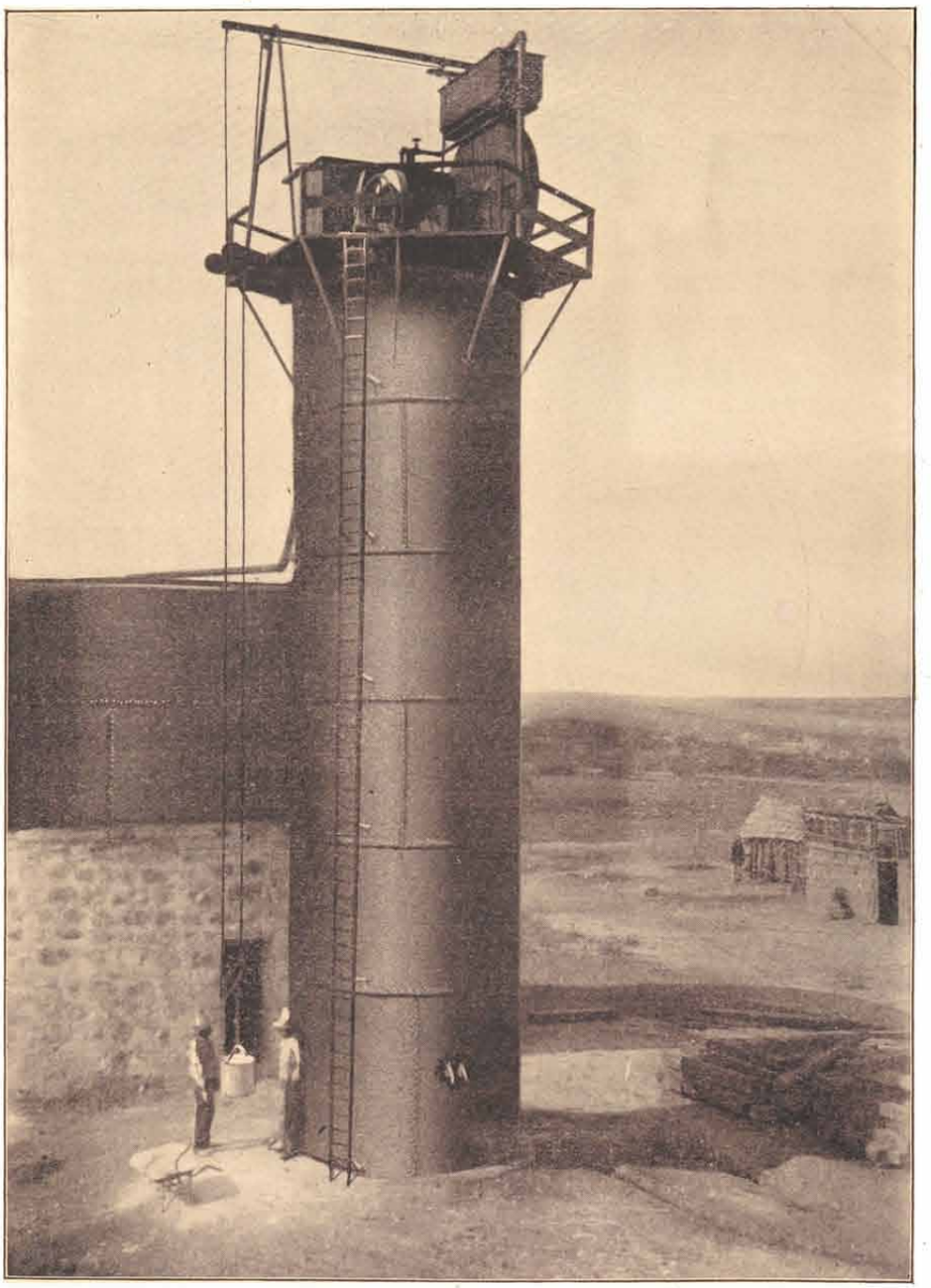
The Kennicott System

THE Kennicott System of Softening Water consists of *automatically* treating *varying quantities of water* with *varying quantities of materials* (always in the same proportion), in an automatic apparatus which purifies and softens the water *at the lowest possible cost.*

The Kennicott Water Softener, as this apparatus is called, is *continuous in its action,* automatically starting and stopping with the beginning and ceasing of the flow of water into the apparatus. It is protected by seven U. S. Patents.

The water is pumped but once into the Softener, and is delivered at the top. The water as it flows into the Softener furnishes all the power the apparatus requires, both for elevating the chemical reagents to the top of the machine, and for mixing them properly with the water to be purified, as well as for operating automatically all the mechanism of the apparatus.

After the impurities in the water to be treated have been precipitated from the water by the chemical reagents, they are automatically removed from the water as it passes through the apparatus, and the purified water overflows from the top of Softener by gravity into the storage tank, without the necessity of repumping.



KENNICOTT WATER SOFTENER

NATIONAL RAILROAD OF MEXICO
Rodriguez, Mexico.

Daily softening capacity, 96,000 gallons. Treats water from the Salado River.

The Kennicott System

(Continued)

EVERY Kennicott Water Softener is built expressly for the particular needs of the water which it is to treat, after that water has been thoroughly analyzed and the proposed treatment carefully outlined by the Kennicott chemists.

The Kennicott System makes use chiefly of lime and soda ash as chemical reagents, for they are the most efficient, the cheapest and the easiest to obtain in the open market, as the following tables fully illustrate:

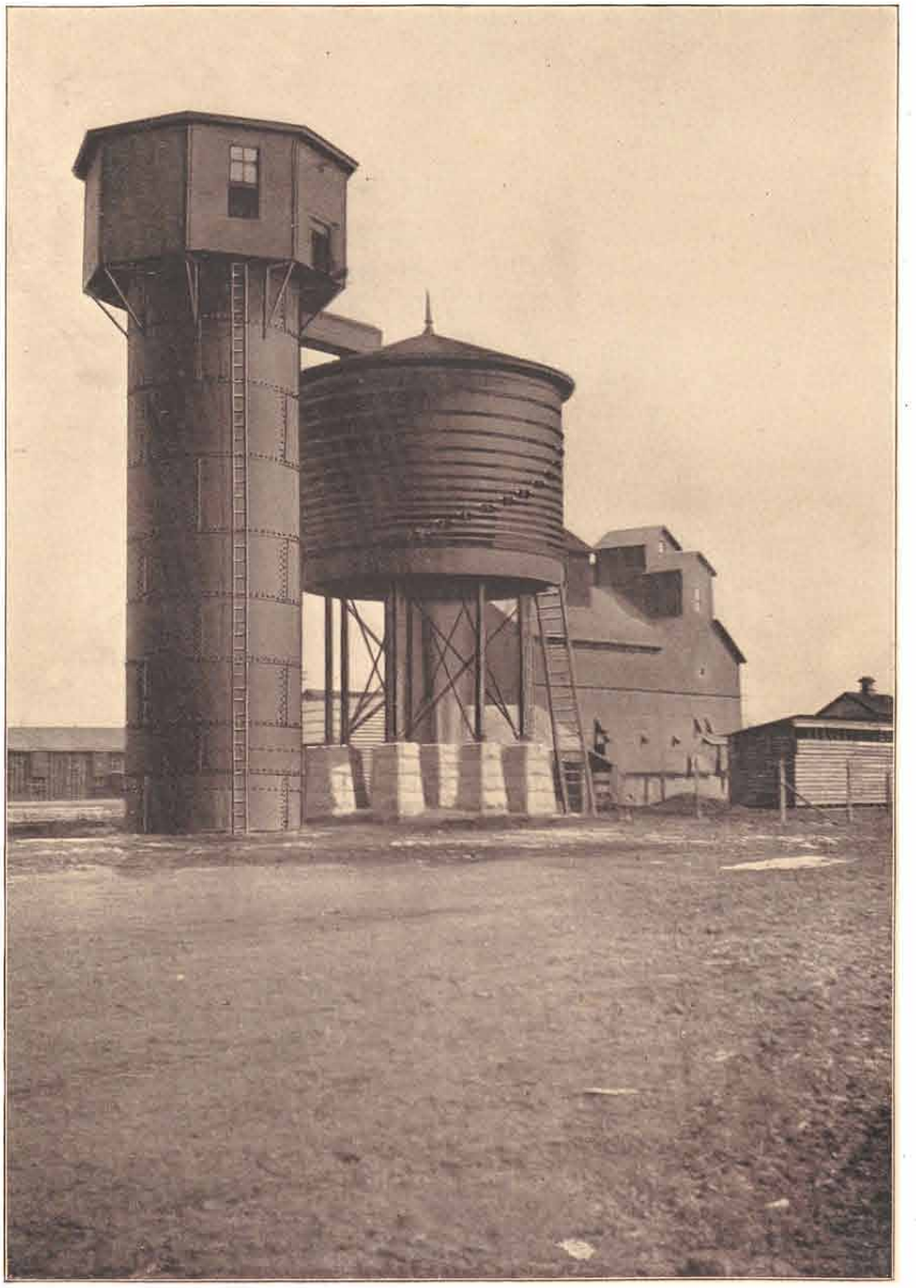
One pound of carbonate of lime requires for its precipitation:

	.56 lbs. of *LIME* at one-fourth cent per pound, -	$.0014
or	.80 " " caustic soda at two cents per pound,	.0160
or	3.15 " " barium hydrate at two and one-half cents per pound, - - - - - - -	.0787
or	2.18 lbs. of sodium phosphate at four cents per pound, - - - - - - - - - -	.0872
or	11.92 lbs. of tannin extract, twenty-seven per cent, at two and three-fourths cents per pound, - -	.3278

One pound of sulphate of lime requires for its precipitation:

	.85 lbs. of *SODA ASH* at one cent per pound, -	$.0085
or	1.94 " " sal soda at sixty-five cents per 100 pounds, - - - - - - - - - -	.0126
or	1.53 " " barium chloride at two cents per pound,	.0306
or	1.60 " " sodium phosphate at four cents per pound, - - - - - - - - - -	.0640
or	8.76 lbs. of tannin extract, twenty-seven per cent, at two and three-fourths cents per pound, -	.2409

Such other reagents are employed, as may be necessary for the proper treatment of any particular water, always bearing in mind the important point of economical efficiency.



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Kearney, Neb.

Capacity, 8,000 gallons the hour. Height to bottom of housing, forty-three feet. Cost of treatment, one and one-tenth cents per 1,000 gallons.

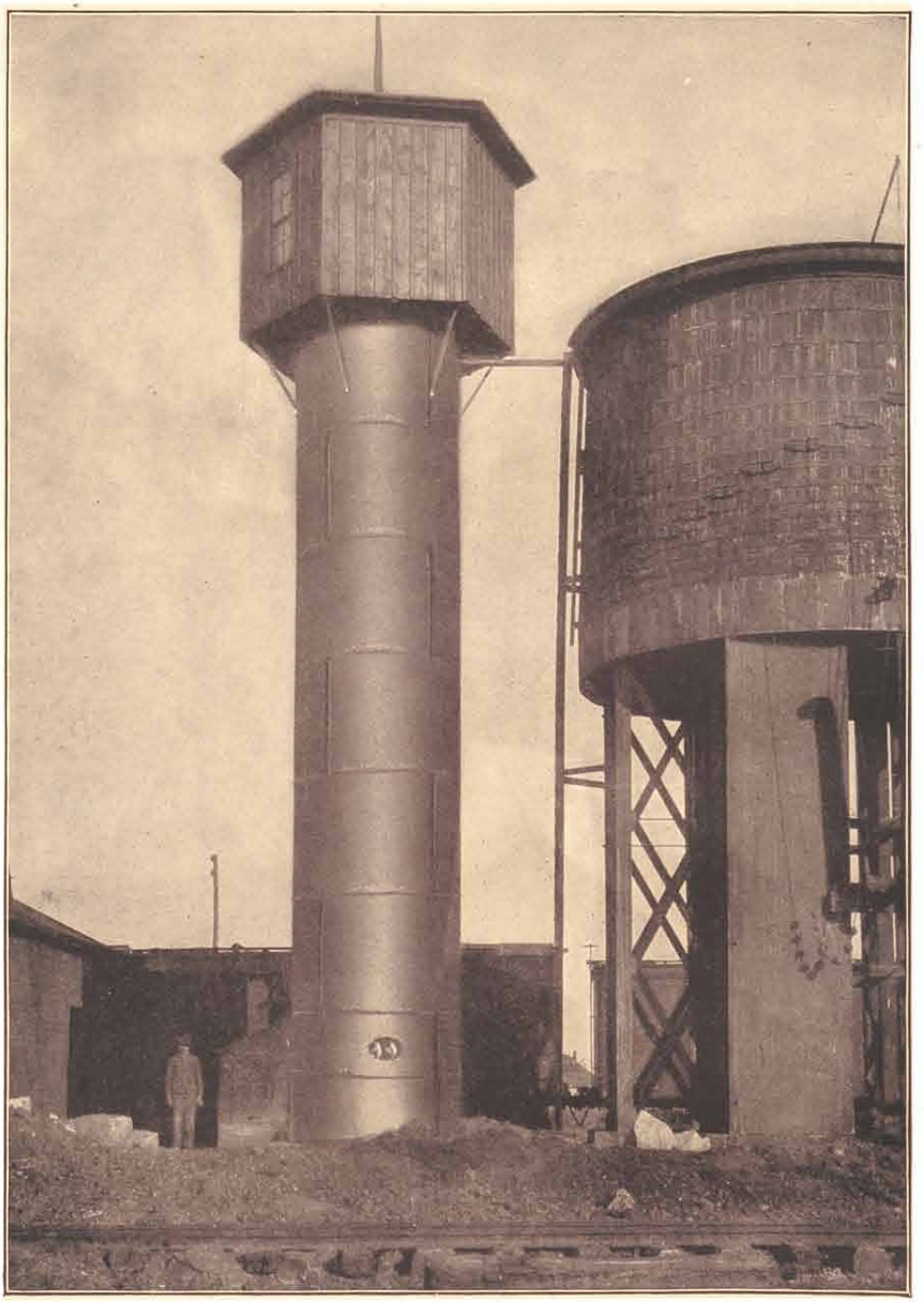
The Kennicott System
(Continued)

THE Kennicott Water Softener requires but a single and simple foundation. The construction throughout is stable, and of the most approved type. The only housing required is at the top of the tank, and is very simple and effective; all parts of the apparatus liable to freeze, including the intake pipe, are inclosed in the main tank, thus protecting them perfectly. These features are fully protected by the Kennicott patents.

The Kennicott Water Softener is designed to occupy the minimum of space with the maximum of capacity, that the water may have plenty of time in passing through it to have all the objectionable scale-forming solids carefully removed. It requires over three hours for the water to pass through the Softener, and to be subjected to the different processes of purification.

The utmost care and attention have been given to every step in the progress of the water through the Softener, from the thorough agitation and mixture of the chemical reagents with the raw water, to the easy removal of the accumulated sludge from the bottom of the apparatus in the form of a thin paste that readily flows when emptied into a common sewer, or which may be saved and utilized in the manufacture of white-wash, boiler lagging, etc.

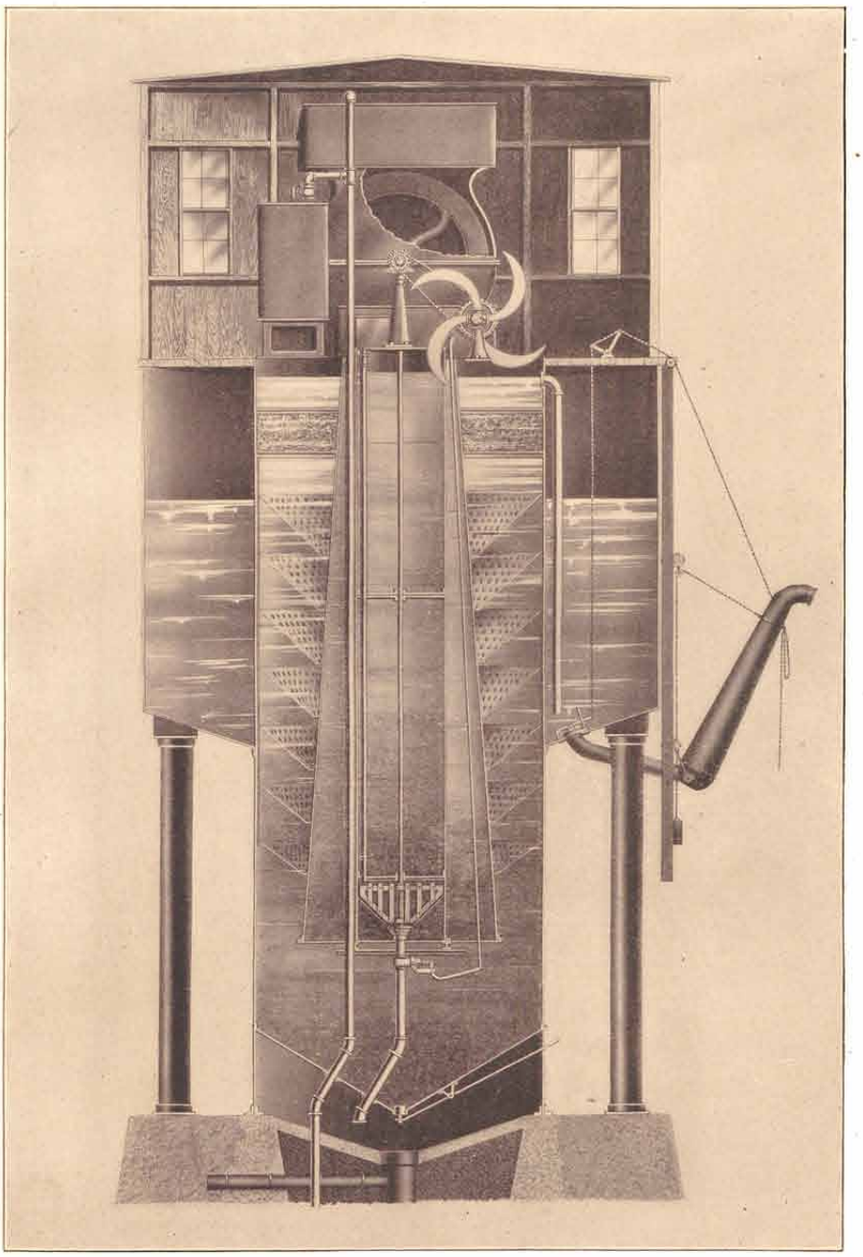
One man in half an hour a day can give all the attention that is needed for the perfect operation of a Softener with a capacity of 10,000 gallons per hour.



KENNICOTT WATER SOFTENER

ATCHISON, TOPEKA & SANTA FE RAILWAY. Lamar, Colo.

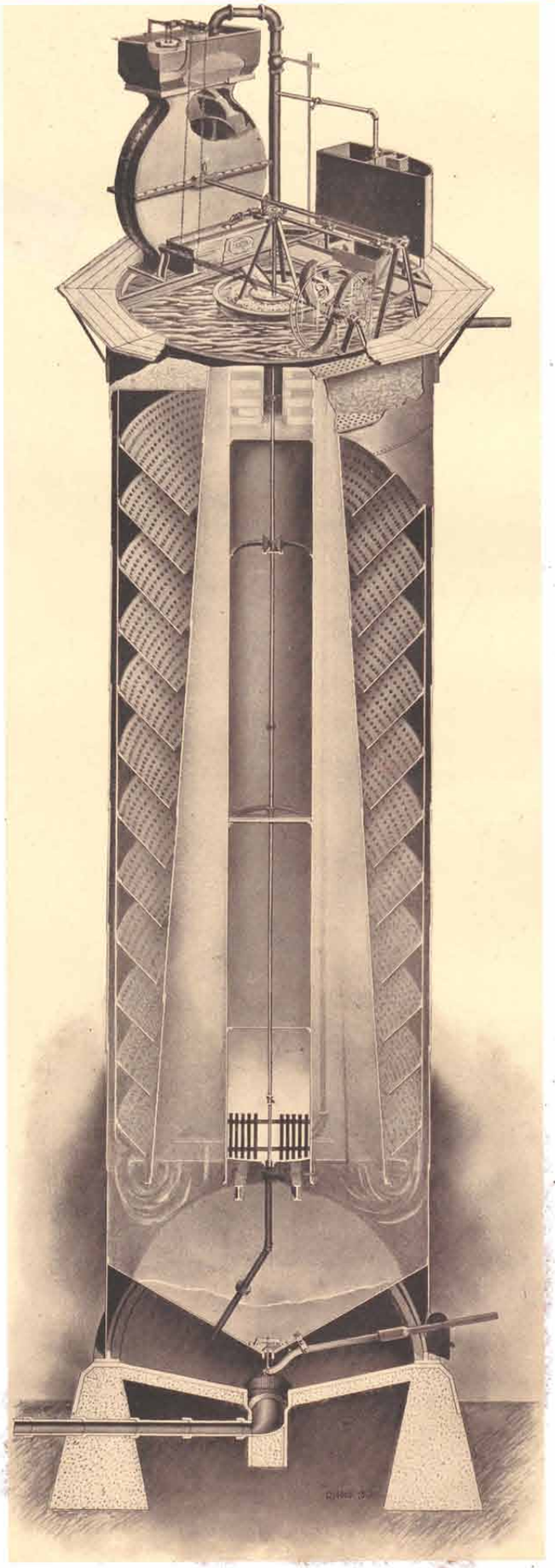
Artesian well water. Capacity, 4,000 gallons the hour. Cost of treatment, one-half cent for each 1,000 gallons. Delivers softened water to storage tank at a height of forty-two feet from rail.



KENNICOTT WATER SOFTENER COMBINED WITH STORAGE TANK

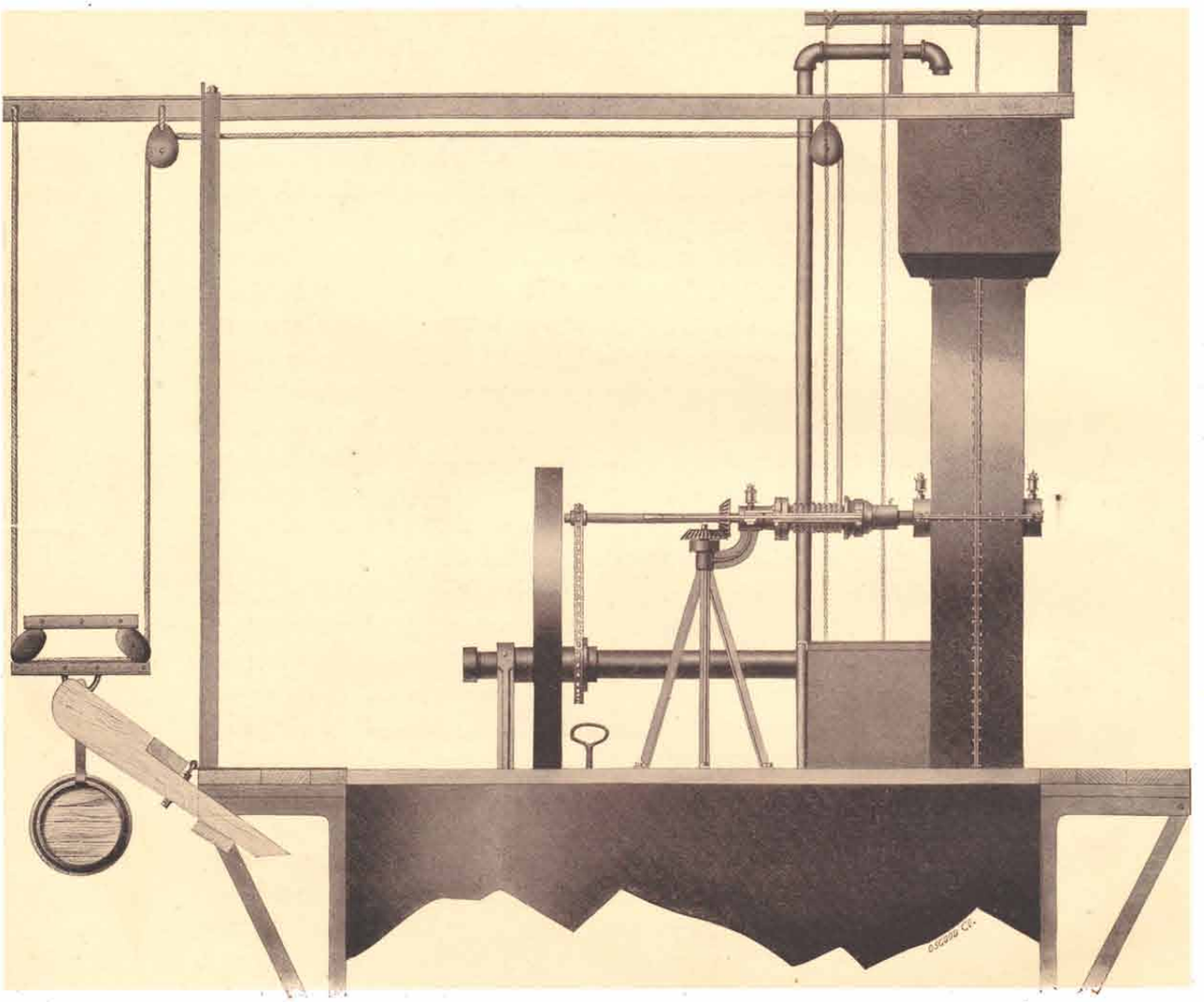
(Patented)

This plant with surrounding soft water storage tank is very compact, neat and durable. A storage tank in connection with a 10,000-gallon-the-hour Kennicott Softener (storage tank having an overhang of six feet) holds 77,000 gallons.



Internal Construction

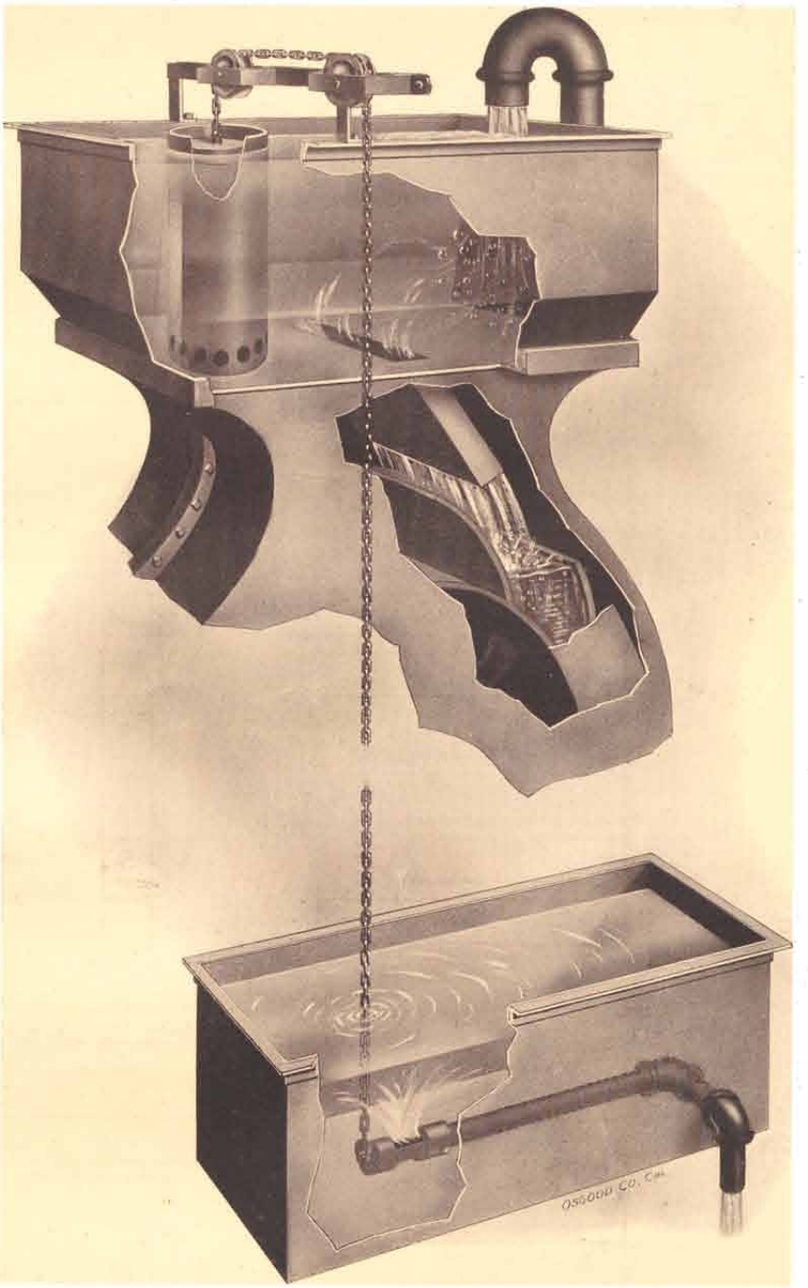
THE cut on the opposite page illustrates the internal construction of the Kennicott Water Softener. The Softener consists of a cylindrical steel tank surmounted by a platform upon which the small amount of housing necessary to protect the apparatus from the weather is erected. Surmounting the tank is the water wheel over which the hard water is first pumped on its way into the Softener. The necessary receptacles for dissolving the reagents and the apparatus for automatically varying the reagents in proportion to the amount of water to be purified are placed upon the top of the tank. Centrally located within the tank is the conical downtake or cone, and within this cone is the lime water saturator, placed in this position in order to protect the movable stirrer from damage by freezing. In a compartment in the top of the lime saturator tank is the mixing chamber. In this chamber the water and the necessary reagents for its purification are intimately mixed, so that the precipitation of the scale-forming material at once takes place. The water with the precipitated lime and magnesia overflows from the mixing chamber and travels slowly downward through the downtake or cone. On account of the size and shape of this downtake the rate of flow of the water constantly decreases, so that the precipitate falls away from the water from which it was formed and collects in the conical bottom of the main settling tank, where it is periodically blown out into the sewer by means of a dump valve. Upon reaching the bottom of the cone or downtake the water turns and rises through the perforated baffle plates shown and the small amount of precipitate left in the water attaches itself to these plates; when sufficient precipitate has gathered upon the plates it slides off and falls to the bottom of the tank. These plates never need to be cleaned. The water finally passes through the wood fiber filter, shown at the top of the apparatus, where the last particles of suspended matter are removed and it emerges from the top of the Softener and flows through the overflow pipe soft and clear, and is discharged into the storage tank without repumping.



KENNICOTT AUTOMATIC HOISTING APPARATUS

(Patented)

Power for mixing the water and reagents is generated by the passage of the water over a water wheel enclosed in the cast iron casing, shown at the right of above cut. Lime and soda ash, as required, is hoisted by this same power in the following manner: A drum loosely journaled on the water wheel shaft is thrown into a clutch by means of a hand lever. The drum winds up the cable and hoists the barrel which raises the tilting platform in passing. The barrel is then lowered upon the platform which has returned to a horizontal position. The barrel may then be opened and the material used.



KENNICOTT AUTOMATIC REGULATING DEVICE

(Patented)

The box or rectangular tank at the top of the cut is the "Hard Water Box" or receptacle into which the water to be purified is pumped. The water flows from this box into the Softener over the water wheel through the opening in the bottom of the hard water box, which opening is set according to the capacity of the machine. One or more reagent boxes, similar to the rectangular one shown at the bottom of the cut, are provided, one for each of the reagents required for the purification of the water. The reagent boxes are kept filled to a constant level with the required solution. As the amount of the water pumped into the Softener varies the head of water in the upper or hard water box, it raises or lowers the float contained therein. This float is connected to the lift pipe shown in the reagent box and raises or lowers this pipe so that the head of the reagent over the opening in the lift pipe is at all times the same as the head of the hard water over the opening in the bottom of the hard water box. Thus the amount of reagents furnished for the purification of the hard water is at all times in exact proportion to the amount of water pumped.

Chart showing grains per gallon before and after treatment by Kennicott Process

Kansas Division—Union Pacific Railroad

Incrusting Solids—Grains per Gallon

Stations	Before Treatment	After Treatment
Lawrence	21.87	5
Topeka	32.86	5
Wamego	28.08	5
Junction City	18.72	5
Salina	25.27	5
Ellsworth	18.79	5
Dorrance	26.07	5

Pounds Incrusting Solids Entering Boilers Daily

Stations	Before Treatment
Lawrence	937.2
Topeka	1408.2
Wamego	802.2
Junction City	534.8
Salina	1083.0
Ellsworth	536.8
Dorrance	744.8

Report of the Examination of the Water Supply, Kansas Division of the Union Pacific Railroad

(Made at the Kennicott Laboratories)

STATIONS	Avg. daily consumption gallons	Hours Softener Runs	Incrusting Solids Grains per gallon before treatment	Incrusting Solids Grains per gallon after treatment	Pounds Incrusting Solids entering boilers every 24 hours before treatment
1. Lawrence .	300,000	20	21.87	5	937.2
2. Topeka . .	300,000	20	32.86	5	1,408.2
3. Wamego. .	200,000	20	28.08	5	802.2
4. Junction City	200,000	20	18.72	5	534.8
5. Salina . . .	300,000	20	25.27	5	1,083.0
6. Ellsworth .	200,000	20	18.79	5	536.8
7. Dorrance. .	200,000	20	26.07	5	744.8
Totals,	1,700,000 gallons				6,047.0 lbs.

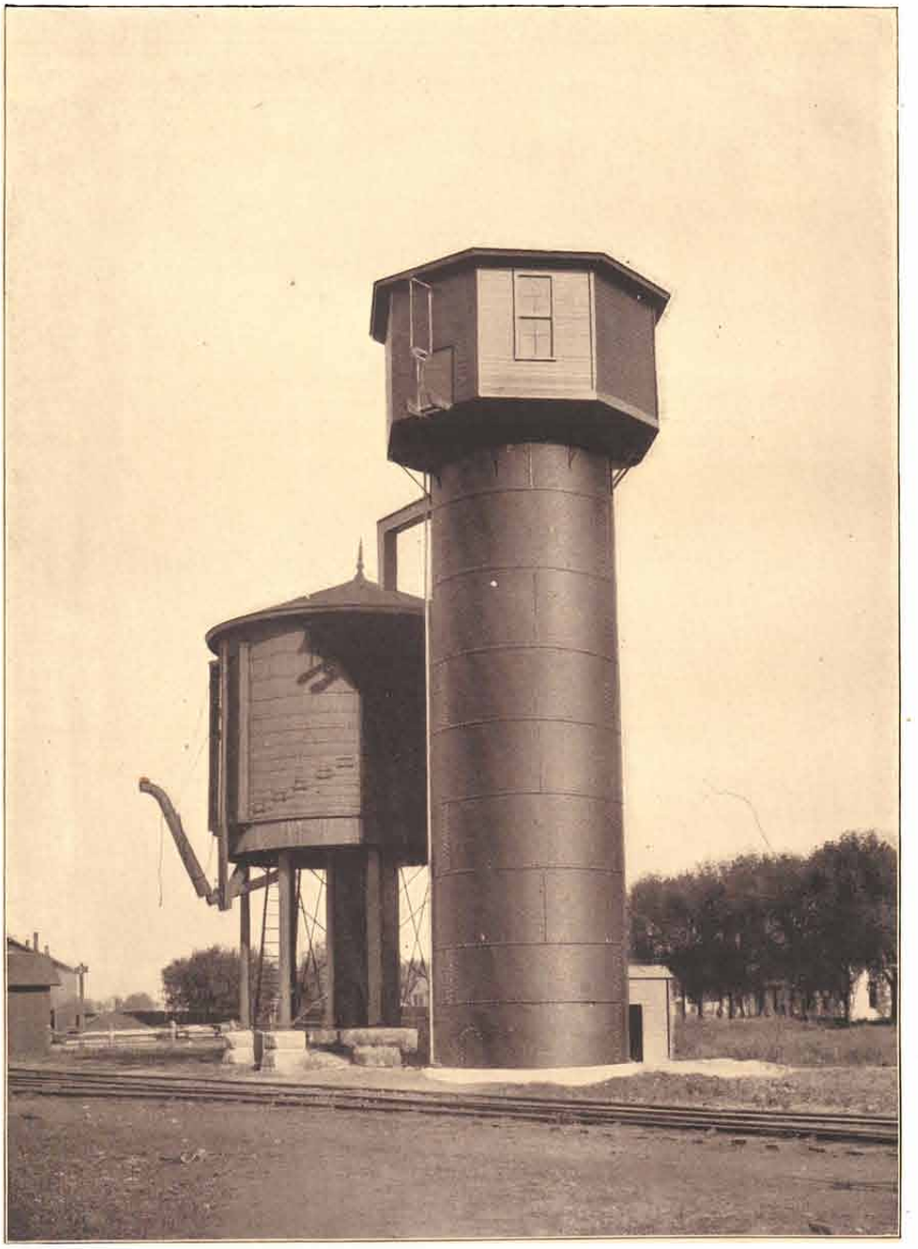
Average cost of treatment per 1,000 gallons, 1.8 cents.
Eight hundred seventy-nine TONS of incrusting solids removed annually.

Detailed Analyses of Seven Stations on the Kansas Division of the Union Pacific Railroad

	Lawrence Water Station	Topeka Water Station	Wamego Water Station	Junction City Water Station	Salina Water Station	Ellsworth Water Station	Dorrance Water Station
Calcium Carbonate . .	13.24	17.66	11.55	12.15	17.49	12.98	16.49
Calcium Sulphate . .	1.50	6.71	9.14	0.64	0.47	0.72	5.75
†Calcium Chloride . . .	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Magnesium Carbonate .	2.50	1.27	1.07	2.82	3.78	2.21	0.20
*Magnesium Sulphate .	2.42	5.23	3.53	1.16	1.26	0.88	1.93
†Magnesium Chloride .	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Sodium Sulphate . . .	2.93	NONE	NONE	2.01	5.88	1.49	0.57
Sodium Chloride . . .	12.05	9.10	10.10	2.10	1.90	4.50	4.00
Sodium Carbonate . .	NONE	NONE	NONE	NONE	0.90	NONE	NONE
Iron and Alumina . .	0.36	0.33	0.32	0.23	0.32	0.23	0.18
Silica	1.85	1.66	2.47	1.72	1.95	1.77	1.52
Incrusting Solids . . .	21.87	32.86	28.08	18.72	25.27	18.79	26.07
Non-Incrusting Solids .	14.98	9.10	10.10	4.11	8.68	5.99	4.57
Pounds of Incrusting Solids in 1,000 gallons	3.12	4.69	4.01	2.67	3.61	2.68	3.72

These analyses are given in grains per United States gallon of 231 cubic inches. A United States gallon contains in round numbers, 58,400 grains.
To change the figures of an analysis given in parts per 100,000 to grains per gallon, multiply by .584; or to obtain an approximate figure, by .6.
To determine pounds of scale-forming or incrusting solids per 1,000 gallons of water, divide grains per gallon by 7.
The incrusting solids form boiler scale.
A water containing more than 10 grains of incrusting solids is classed as a hard water.
A water containing more than 30 grains of *non*-incrusting solids will give trouble with foaming or priming in a locomotive boiler, although these solids may reach as high as 40 or even 50 grains without causing trouble in a stationary boiler.

Incrusting solids in red ink. *Forms scale only in the presence of carbonate of lime. †Corrosive.



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Columbus, Neb.

Capacity, 10,000 gallons the hour. Cost of treatment, one and one-fifth cents per 1,000 gallons.

Results Obtained

THE amount of scale-forming matter removed from the water by a Kennicott Water Softener depends upon the condition of the water, and the number of gallons treated.

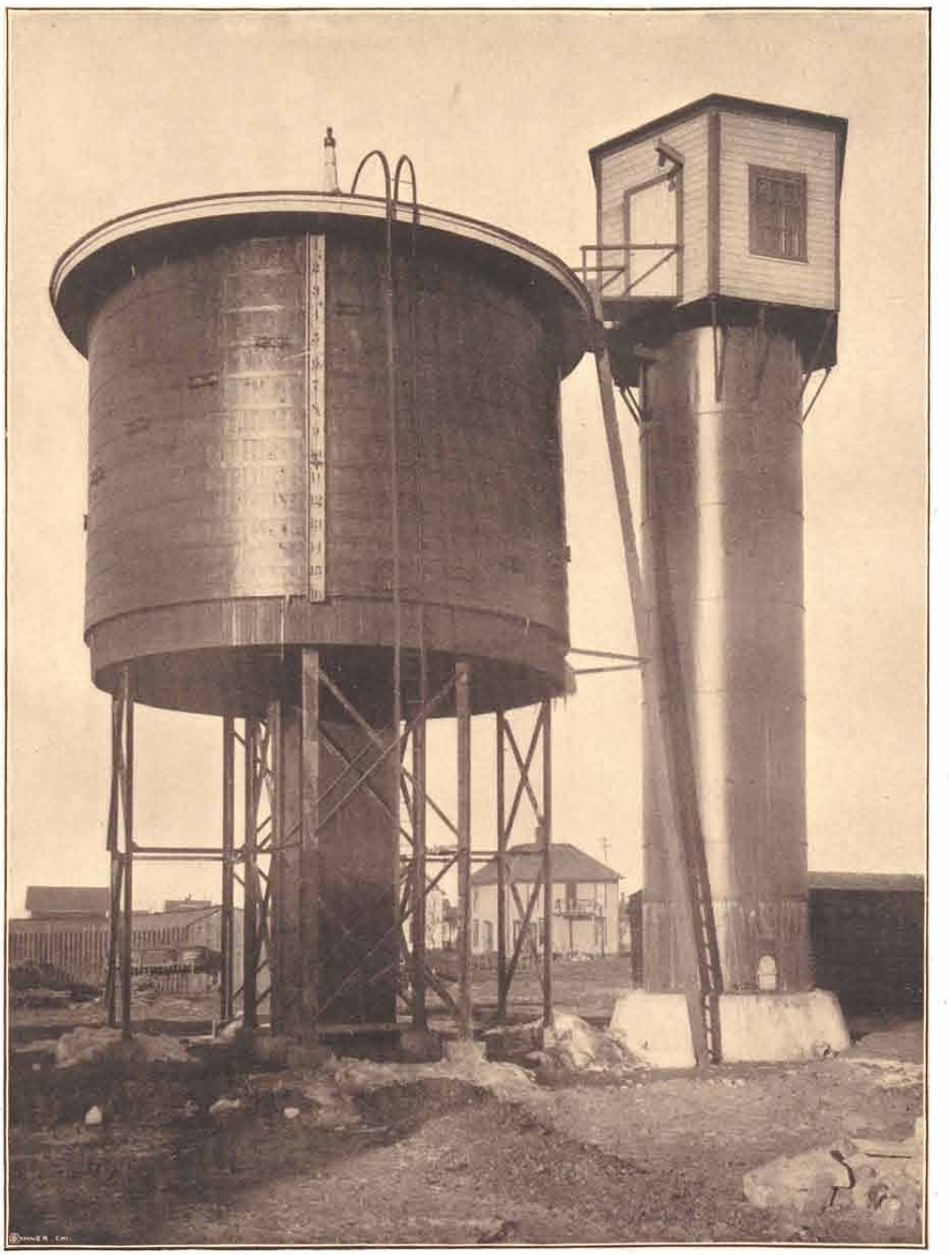
By referring to the table on page 37, it will be observed that at Station No. 2 (Topeka) 32.86 grains of incrusting solids entered the boilers with each gallon of water used before treatment—equivalent to *1,408.2 pounds daily;* whereas, after treatment we have guaranteed that the incrusting solids shall not exceed 5 grains per gallon.

To put it another way, a Kennicott Water Softener at Topeka Station will remove *35,820 pounds* of incrusting solids from the water every thirty days—equal to *218 tons each year.*

While at Station No. 5 (Salina) a Kennicott Water Softener will remove *317,185 pounds of scale-forming matter each year.*

Kennicott Water Softeners at these *seven* stations on the Kansas Division of the Union Pacific Railroad will remove the enormous total of *1,757,110 pounds* of scale-forming matter each year.

And this is only an ordinary instance of the enormous amount of scale-forming solids that daily finds its way into steam boilers.



KENNICOTT WATER SOFTENER

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILROAD. Amboy, Minn.

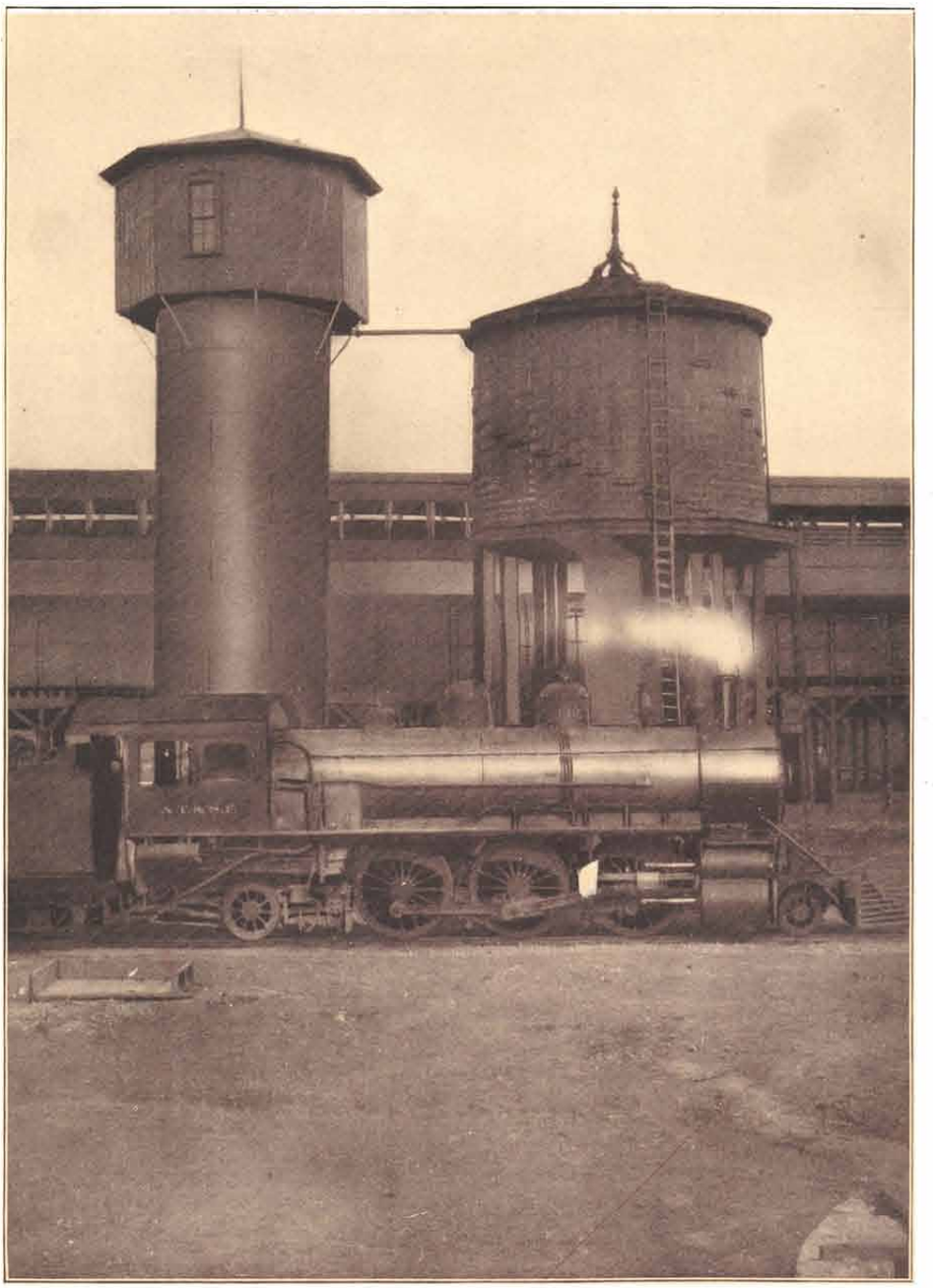
Daily softening capacity, 72,000 gallons. Removes 5.659 tons of incrusting solids monthly.

Expense of Operation

THE cost of operation of a Kennicott Water Softener varies somewhat, but the general run of waters can be treated at an expense of from one to two cents per 1,000 gallons—including cost of chemical reagents and labor.

By referring to the items beneath the different Softeners illustrated in this book, you can obtain an accurate idea of the actual cost of chemicals—and the item of labor is insignificant, for a 10,000-gallon-the-hour Softener requires but a few minutes attention each day—the station pumper can easily see to the charging of the apparatus and the blowing off of the sludge, in connection with his other duties.

The Kennicott System uses the two cheapest reagents known—common lime and soda ash. Both are easily obtainable at any time in the open market—the price of soda is about $1.00 per hundredweight; the price of lime is usually $0.50 per barrel of 200 pounds.



KENNICOTT WATER SOFTENER

ATCHISON, TOPEKA & SANTA FE RAILWAY. Dodge City, Kansas.

Deep well water from four wells. Water raised by air lift. Supplies water for locomotives and round-house boilers, 192,000 gallons daily. The sludge from this machine is very white and makes a good grade of whitewash.

Railroad Economy

IN these days of keen competition it is the keeping down the cost of operation that produces the dividends. Low rates necessitate rigid economy in the operating department.

The locomotive is the backbone of the railroad. Take away the locomotive, and you stop traffic. Stop traffic, and you stop dividends.

Increase the efficiency of the locomotives on a road, and you immediately increase its earning capacity.

Ordinarily a locomotive is undergoing repairs fifteen per cent of its time—repairs mainly occasioned by *boiler scale,* caused by the use of *hard* water.

Stop the use of *hard* water, and you increase the actual working time of the locomotive materially.

The idle time is not the only loss. One-sixteenth of an inch of boiler scale causes a dead loss of twelve per cent of fuel—three-eighths of an inch means half the fuel is wasted.

A locomotive burns on an average about $5,000.00 worth of coal a year. Figure the loss in wasted energy.

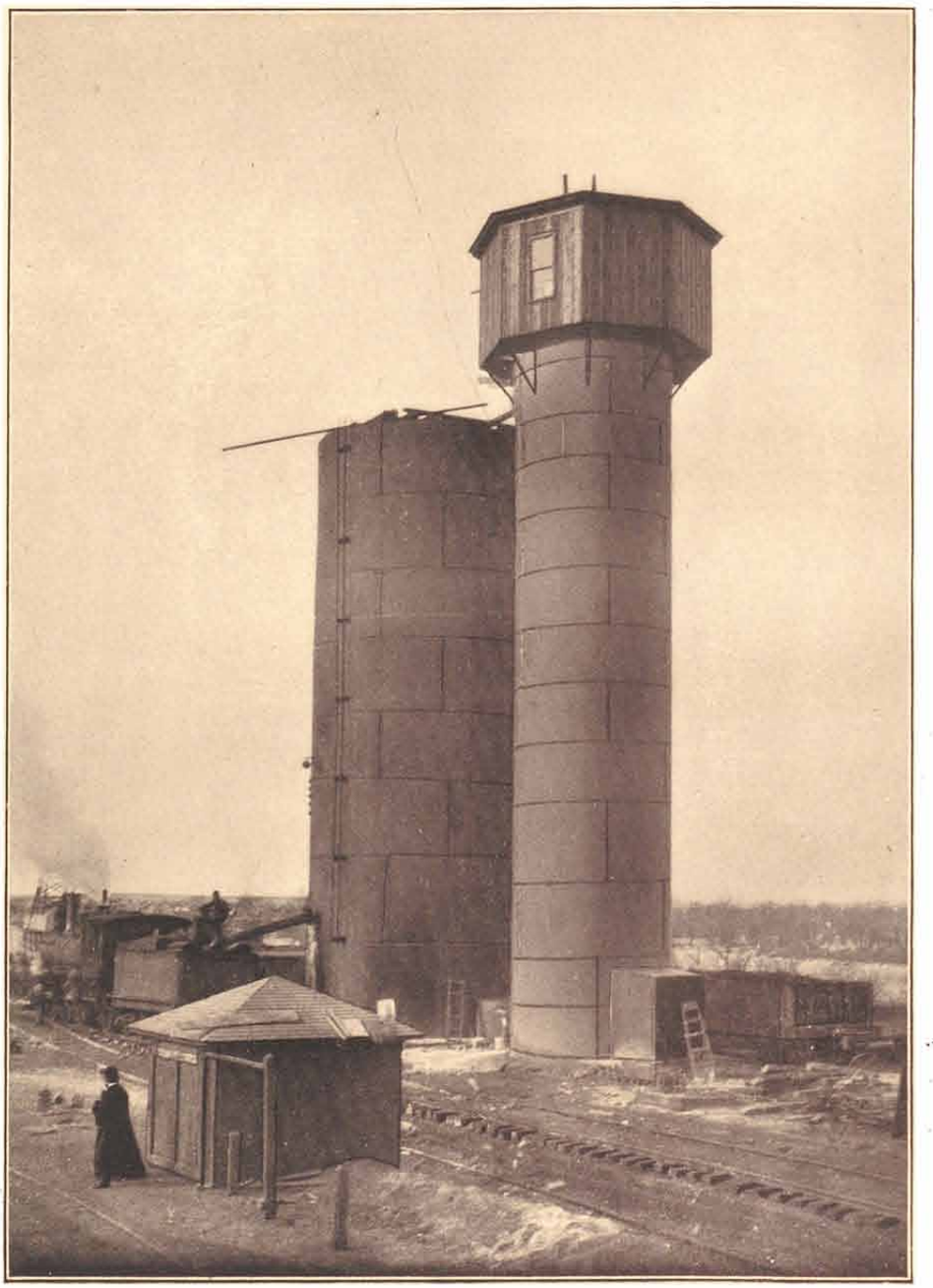
Then there is the *irreparable damage* to the life of the locomotive from the corroding of the boiler, where impure water is used.

There are only two ways in which these heavy losses can be positively prevented:

(1) Use a natural soft water (if possible to obtain in sufficient quantity), or

(2) Treat a hard water so as to remove its impurities *before* it goes into the boiler.

The simpler the method of treatment, the more economical it will be—providing it removes the impurities.



KENNICOTT WATER SOFTENER

ATCHISON, TOPEKA & SANTA FE RAILWAY. La Junta, Colo.

Daily softening capacity, 300,000 gallons. Softens water from eight artesian and surface wells, delivering the purified water to sixty-foot steel Santa Fe Standard storage tank. There is removed from this water nearly twelve tons of scale-forming material each month. Cost of treatment, one and one-half cents per 1,000 gallons.

Railroad Economy

(Continued)

THE Kennicott Water Softener is the most simple, efficient and economical apparatus for softening water. It is particularly adapted to the railroad service, because the system is automatic and continuous, and the softened water does not have to be *repumped to a storage tank.*

It is the cheapest method of treatment. It requires no expert attention, and uses the cheapest known softening materials—lime and soda ash (see page 27).

The entire cost for softening water by the Kennicott System averages from one to two cents for each one thousand gallons treated.

The Kennicott System does *all* that any other softener can do—*and more*—and does it at lower cost.

The Kennicott System has been adopted as the standard on the Union Pacific and Pittsburg & Lake Erie railroads. It is the only process that has received *second* and *third* orders from the same railroads.

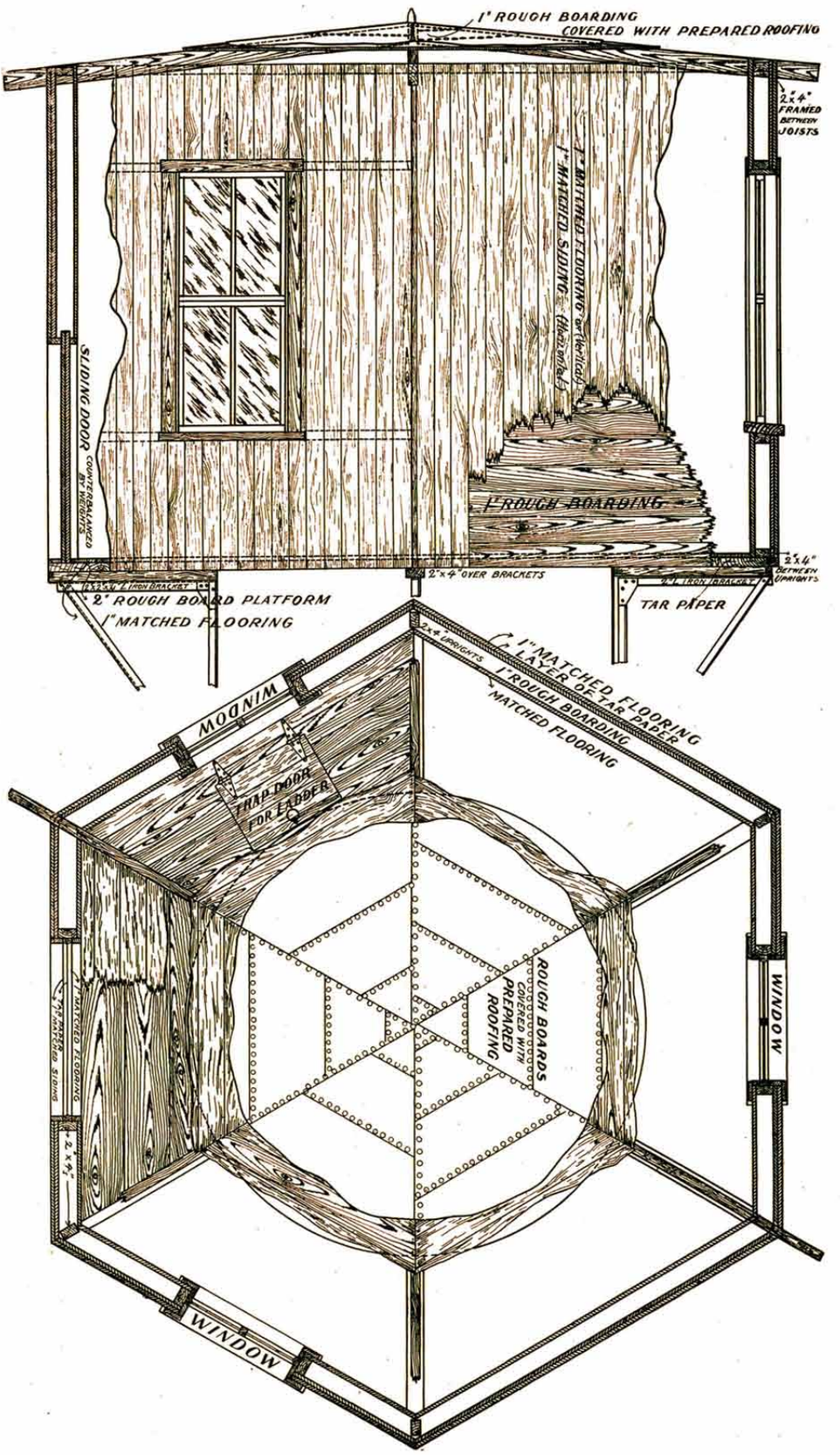
The Kennicott Water Softener is especially adapted to the railroad service for many reasons:

It treats varying quantities of hard water with the correct, proportionate quantities of chemicals (reagents) automatically and without resetting.

Danger of freezing is practically overcome by inclosing the lime saturator and the intake pipe in the main tank (device patented).

The Softener rests upon a single and simple foundation.

The method of construction requires only simple housing for the top of the apparatus (see page 46).



HOUSING FOR KENNICOTT WATER SOFTENER

This standard housing, surrounding the top of the Softener, is sufficiently frost-proof for very severe climates.

Railroad Economy

(Concluded)

NO power is required for the operation of the machine, other than the pumping of the hard water into it—the flow of hard water operates a waterwheel that supplies all power needed.

The machine starts and stops automatically, according to the supply of hard water. The amount of water flowing into the Softener, up to the maximum capacity, is regulated automatically by the amount drawn out.

Duplicate soda tanks overcome the necessity of shutting down while preparing a fresh supply.

The lift device (see page 34) raises the chemicals required to the top of the machine without hard manual labor.

The wood fibre filter requires no water for washing—an important saving.

Each machine is built expressly for the water it is to treat, and only the best materials and workmanship are used.

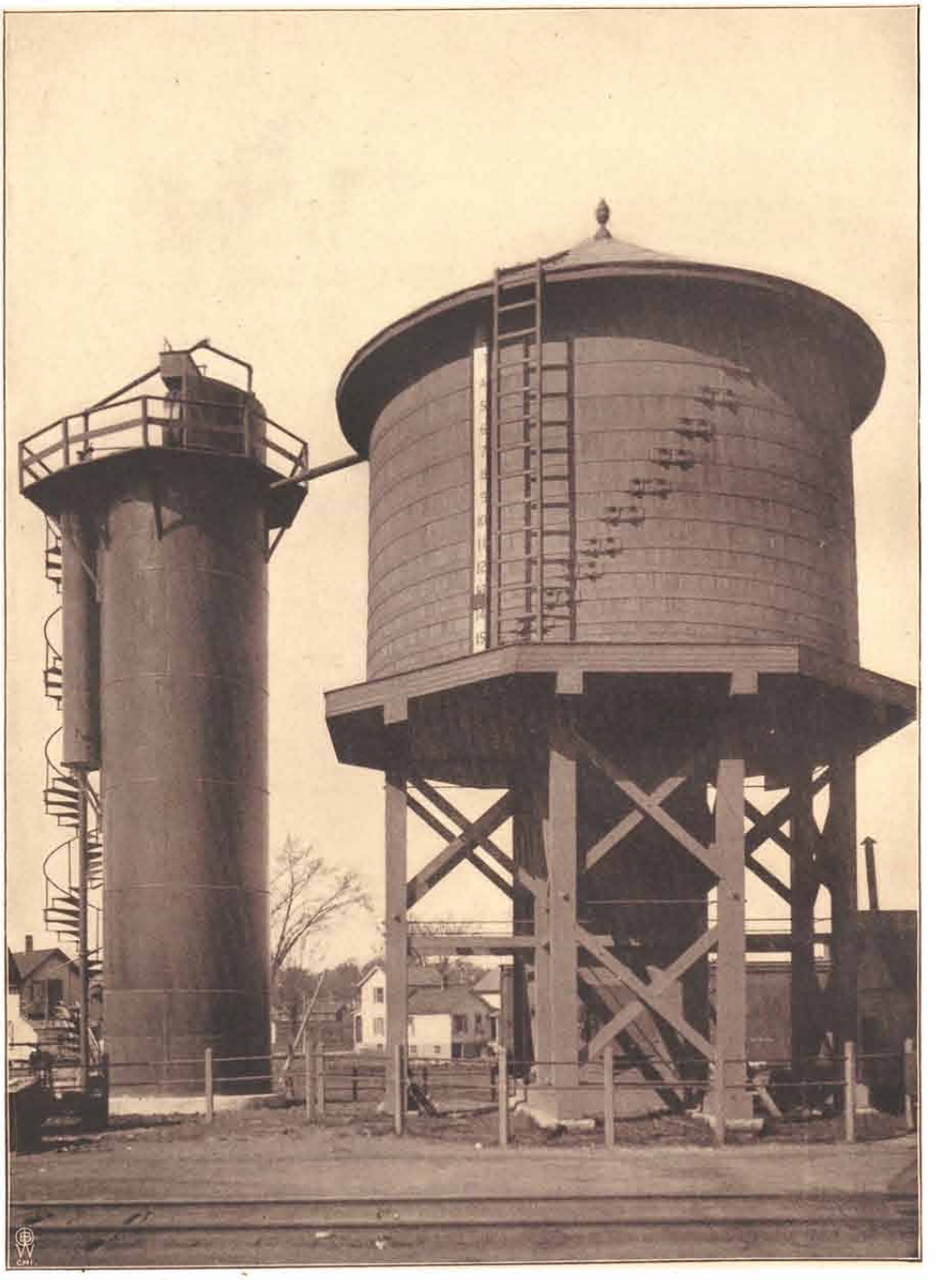
The neat appearance and the entire absence of complicated tanks, pipes and valves are points of decided superiority.

The shape and size of the cone or downtake is such that the precipitation takes place in the direction of the flow of the water; the precipitation is thus greatly aided.

The purified or softened water flows out from the top of the machine; thus the water has sufficient head to run to a separate storage tank, without repumping.

These are some of the good points about the Kennicott Water Softener—points not found in any other system for the softening of hard water.

But over and above these points of claimed superiority is the practical proof of the actual demonstrations, as shown in the accompanying photographic illustrations.



KENNICOTT WATER SOFTENER

NEW YORK, ONTARIO & WESTERN RAILWAY. Oneida, New York.

Capacity, 5,000 gallons the hour. Treats water from Oneida Creek.

Locomotive Boilers

THE use of *hard* water in locomotive boilers is the cause of their not steaming to their full capacity; necessitates the burning of enormous quantities of additional coal; and is the chief reason for cracked plates, leaky flues, and endless repair bills.

Here is a conservative estimate of the saving effected by the installation of the Kennicott System—actual statistics prove the estimate is not strong enough, by fully one-half, in favor of using softened water:

The average locomotive costs, say $15,000.00; it consumes about $5,000.00 worth of coal, and 5,000,000 gallons of water a year; it requires about $1,200.00 worth of repairs annually, and has to be washed out when using hard water on an average of each 500 miles run; it is laid up for repairs fifteen per cent of its time.

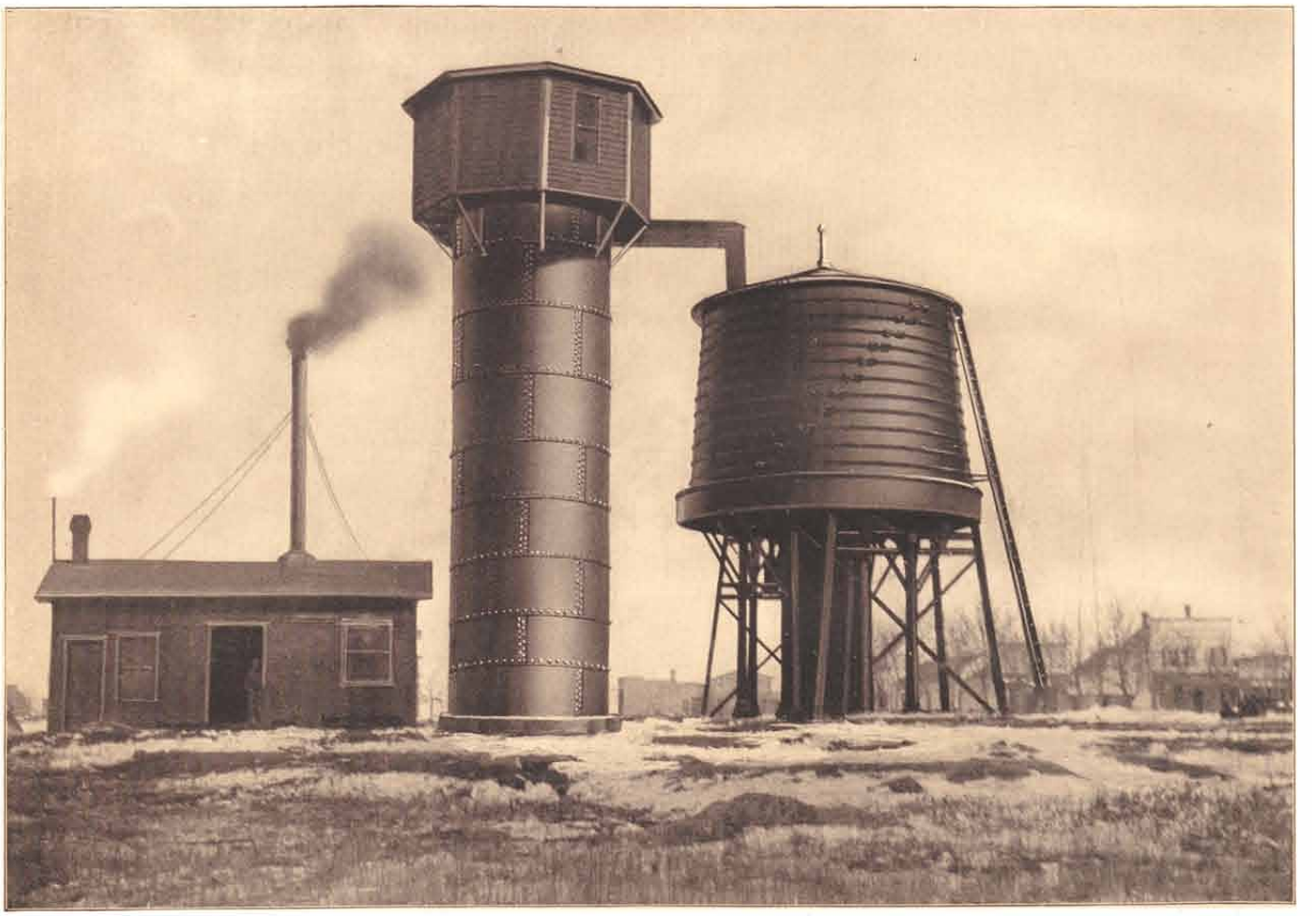
When the same locomotive is fed from Kennicott Water Softeners the saving in coal runs from five per cent to ten per cent—say five per cent, or $250.00.

The saving in shop repairs will be from $300.00 to $600.00—say only $300.00.

The engine will run ten times as far without washouts—say a net saving for this item of $100.00.

The engine will not be laid up for repairs and washouts more than ten per cent of its time—a saving of five per cent of its earning capacity.

And the life of the engine will be practically doubled.



KENNICOTT WATER SOFTENER

UNION PACIFIC RAILROAD
Julesburg, Colo.

Capacity, 8,000 gallons the hour. Height to bottom of housing, forty-three feet. Cost of treatment, one and one-fourth cents per 1,000 gallons.

Locomotive Boilers

(Concluded)

FIGURE it out for yourself. How many locomotives are there on your division? What is their average life? Then consider that the cost of supplying these boilers with softener and purified water by the Kennicott System is approximately $100.00 yearly for each locomotive, and that you actually save from *$500.00 to $1,000.00 annually per locomotive* in coal and repair bills alone.

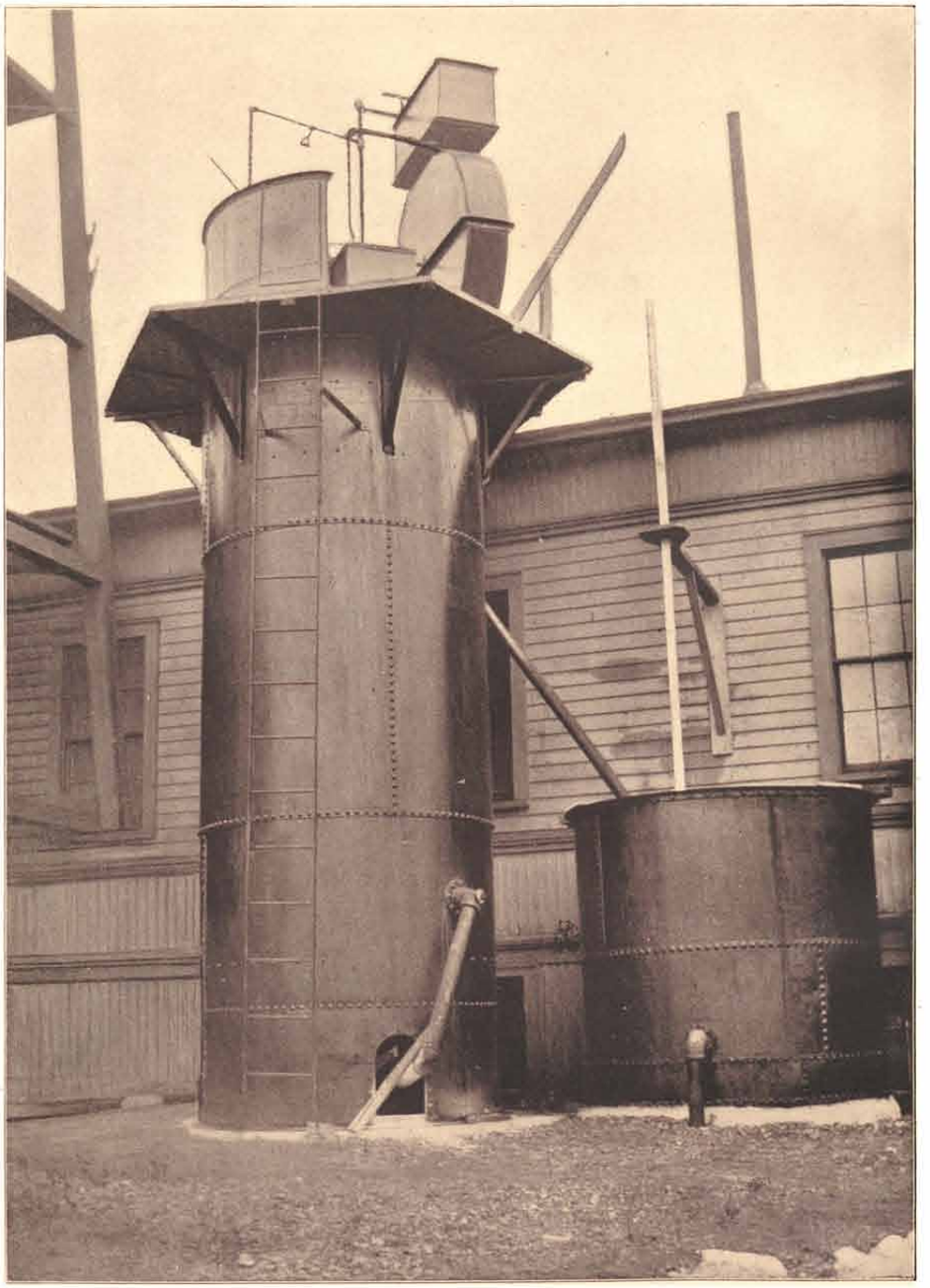
Add to this the saving in the number of locomotives required—when the water is softened, *nine* engines will practically do the same work you now require *ten* to do on hard water—the steaming efficiency of each boiler is increased and the time required for repairs is materially lessened.

Now add the proportionate yearly saving in the life of the locomotive, reduced to dollars and cents.

And, finally, add the increased earnings of each locomotive in service—at the lowest calculation at least five per cent of its full earning capacity.

Multiply the total by the number of engines on your road, and you'll have a fair estimate of what the Kennicott Water Softener System will be worth to your Company each year.

KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

MIAMI POWDER COMPANY
Xenia, Ohio.

Capacity, 1,000 gallons the hour.

Industrial Plants

EVERY power plant should use softened water for its steam generating boilers—many industrial plants save large sums of money each year by having soft water to use in the various processes of manufacture.

The saving by keeping boilers free from scale is a very important item, which no manager can afford to overlook.

For every 1,000 horse-power generated by steam boilers, the Kennicott System will actually save $2,000.00 annually for any industrial plant.

The following table is computed on averages secured from repeated tests, and is a very conservative statement of the facts:

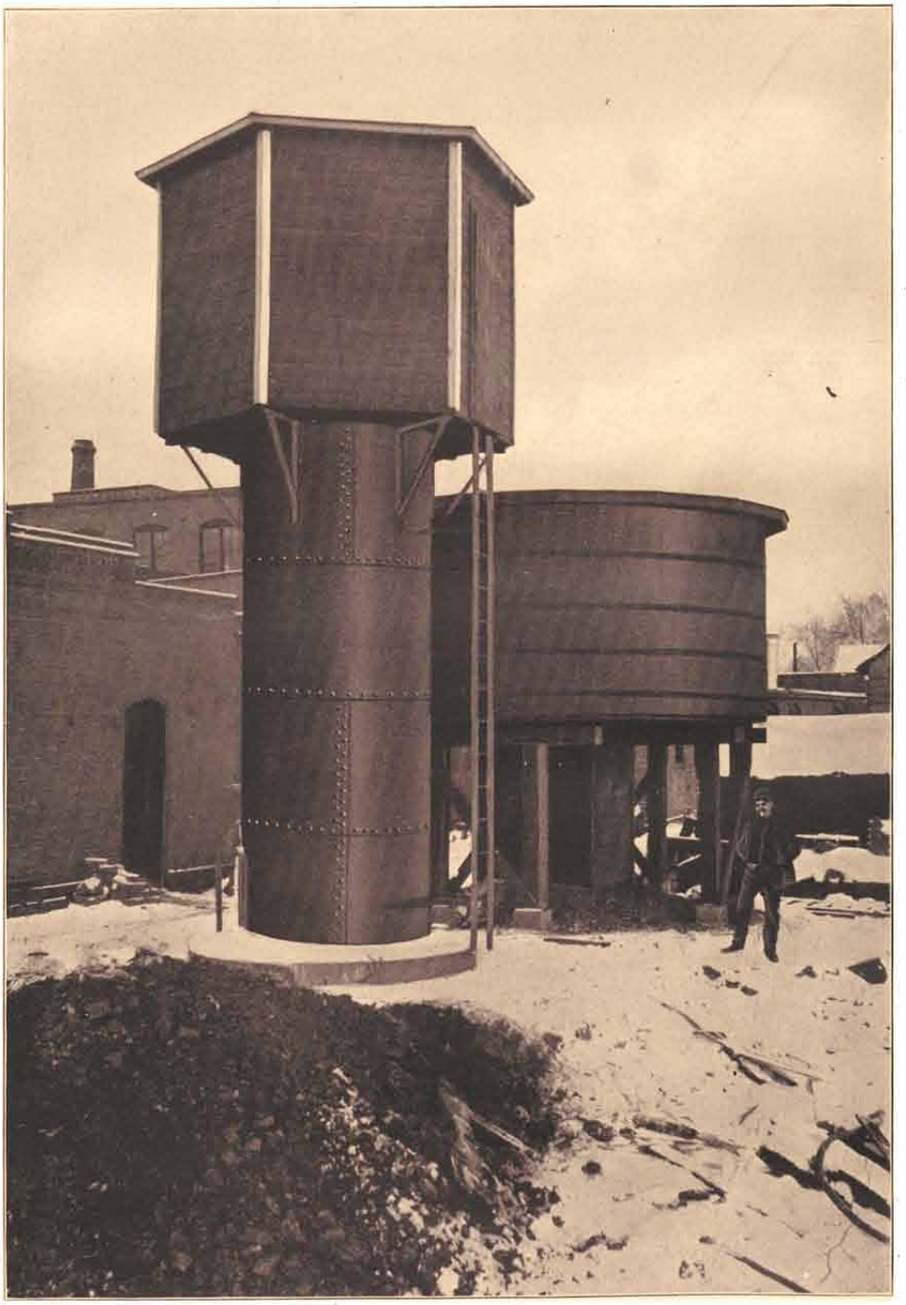
A 1,000 horse-power boiler installation evaporates 40,000 gallons of water daily and consumes twenty-one tons of coal at say $2.00 per ton.

When the boilers are supplied with softened and purified water, the expense of cleaning is reduced fully $1.00 per horse-power per year, a saving of - - - - - - - - - - $1,000.00

Extra cost of coal to get up steam after shut-downs, -	100.00
Repairs saved by use of soft water, - - - - - -	250.00
Amount previously expended for boiler compounds, -	250.00
Ten per cent of coal bill saved, or $4.20 per day, - -	1,314.60
Gross saving per 1,000 horse-power, - -	$2,914.60
Cost of softening 40,000 gallons water daily, at one and one-half cents per 1,000 gallons, by the Kennicott System,	$187.80
Interest and depreciation, - - - - - - - -	567.00
	$754.80
Net saving per year per 1,000 horse-power, -	$2,159.80

In many instances the saving in fuel alone is over fifteen per cent.

KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

MANKATO WOOLEN MILLS COMPANY. Mankato, Minn.

Capacity, 750 gallons the hour. Softens water from a flowing artesian well. The purified water is used for boiler feed, wool washing and dyeing.

Industrial Plants
(Continued)

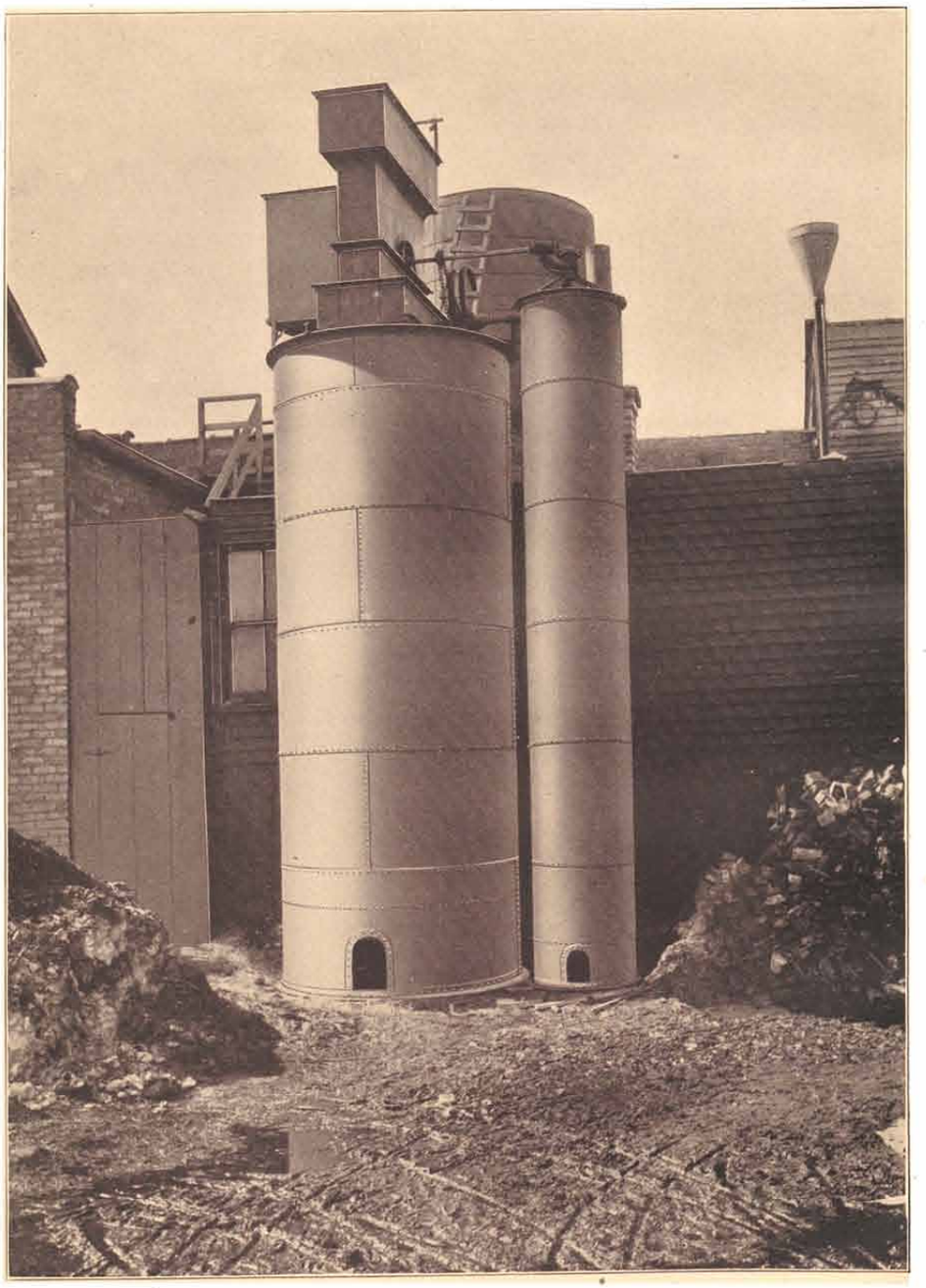
IN addition to the saving effected by the use of soft water in boilers, it is an important item of economy in many industries. Laundries, for example, can effect a material saving by using soft water. Each grain of lime in one gallon of water produces what is called one degree of hardness. Each degree of hardness destroys 1.7 pounds of the best hard soap before a lather is produced in 1,000 gallons of water and leaves an insoluble curd which becomes entangled in the fabrics washed, and cannot be removed by rinsing. The heat of the iron decomposes these curds, and leaves brownish soap spots on the goods.

The following table shows the comparative amounts of soap required to produce a permanent lather in waters of different degrees of hardness, and the saving effected by the use of soft water:

Degrees Hardness	Pounds Soap Destroyed per 1,000 Gallons	Cost of Soap at 5 cents per pound
5	8.5	$0.41
10	17.0	0.82
15	25.5	1.23
20	34.0	1.64
25	42.5	2.05

Goods washed in softened water are cleansed with a minimum amount of soap, are much finer and whiter in appearance, and softer in texture, while no dark color appears at seams and hems.

In woolen, silk and cotton mills soft water is invaluable. The saving of soap is the same as in laundries, while soft water insures an absolutely even surface for dyeing, and reduces the amount of dye required.



KENNICOTT WATER SOFTENER

OTTER CREEK COAL COMPANY
Brazil, Indiana.

Softens water pumped from the coal mine for use in boilers of hoisting plant.

Industrial Plants
(Concluded)

PAPER Mills require a soft water to secure the best results, for paper pulp forms a filter that absorbs any impurities in the water, and these impurities reduce the quality and increase the cost of manufacture. The Kennicott System removes them all.

For ice plants the advantages of purified water are manifest—keeping condensers and boilers free from scale and removing the carbonic acid gas which is largely responsible for the core in can ice.

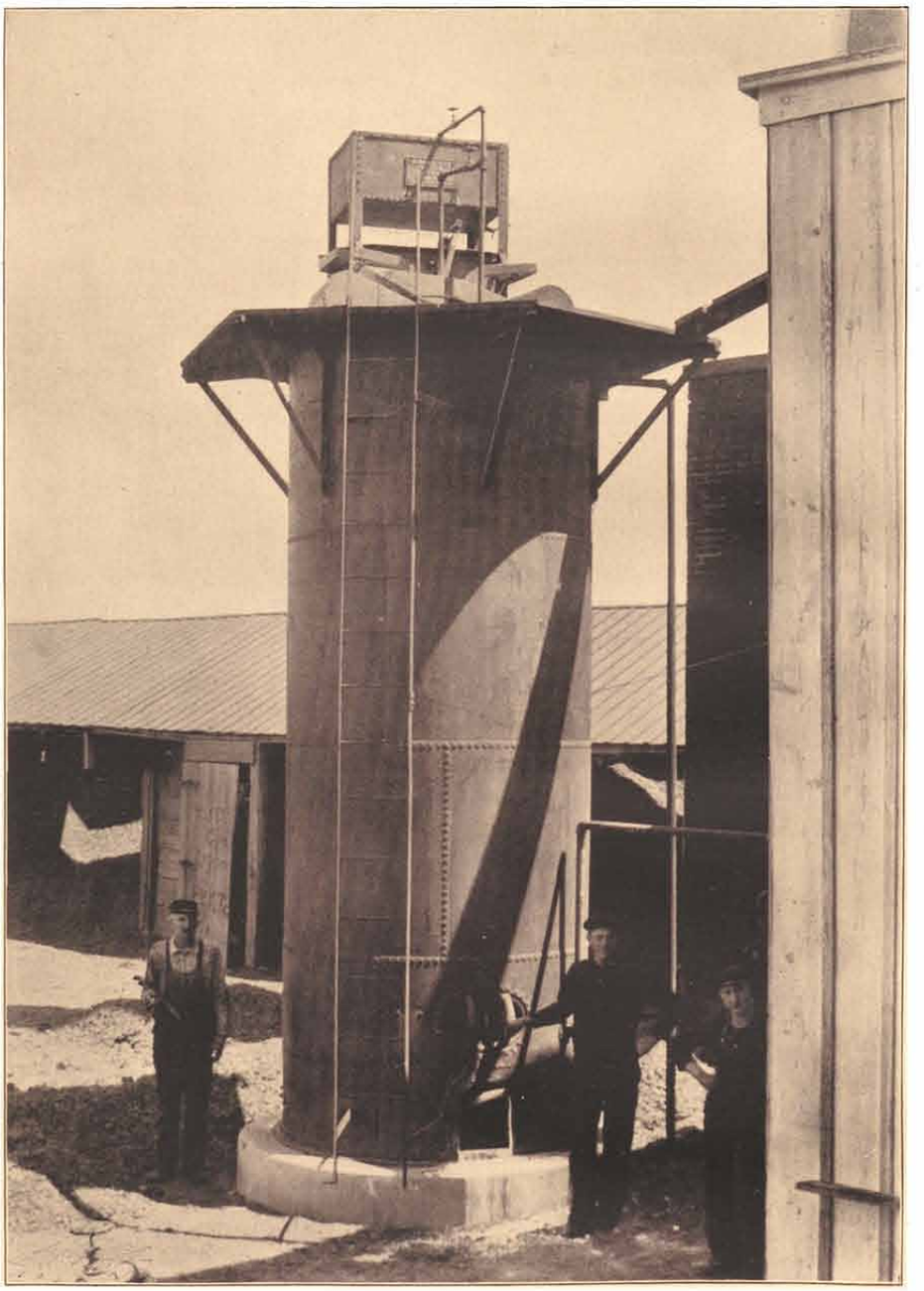
For breweries a water hard with sulphate of lime and free from calcium and magnesium carbonates is essential to a good brew. A special Kennicott Water Softener is built for brewers, that removes the calcium carbonate and at the same time adds the exact proportion of sulphate of lime or gypsum desired for the brew—and the same apparatus will furnish a perfectly softened water for boiler use.

For distilleries, refineries, etc., soft water is most desirable. Fermentation takes place quicker with soft water than with hard, and retorts, condensers, etc., attain their highest efficiency only when soft water is used.

For tanneries soft water is essential, as salts of calcium and magnesium, unless removed by the softening process, precipitate the tannin from the tannin extract, thereby rendering a portion of the extract useless, and greatly increasing the cost of tanning the hide. Soft water also produces a more uniform and softer leather than hard water.

An ideal city water supply can be secured by the Kennicott System. The impurities are absolutely removed—the hardness is gone—and with it the lime that coats pipes and utensils—the laundry work is made easy—and the public health is improved.

KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

EL RENO ICE & COAL COMPANY
El Reno, Oklahoma.

Capacity, 1,000 gallons the hour.

Personal Investigation

WATERS vary—and so do conditions. Therefore, before making a proposition for the installation of a Kennicott Water Softener we prefer to have a sample of such water for our own analysis, as we make certain determinations which do not usually enter into the ordinary water analysis.

Such samples should always be forwarded in glass containers, as samples sent in stoneware jugs frequently become contaminated or changed in composition due to the solvent action of the water upon the material from which jugs are made.

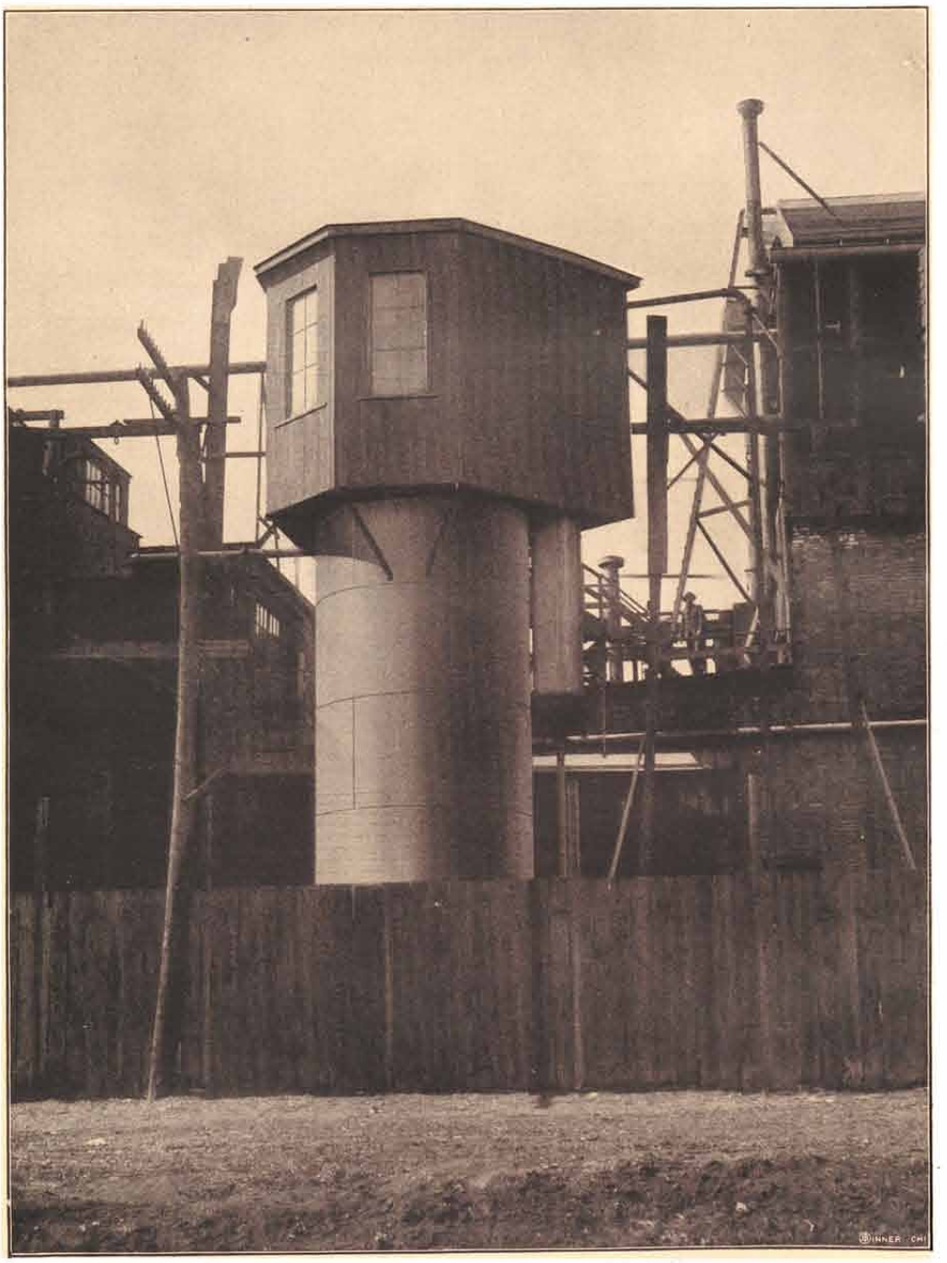
This enables us to make the most economical plans for the construction of the Softener and to insure its highest efficiency.

It also enables us to study the needs of your plant intelligently at first hand, where the water is to be used for other than boiler purposes.

Each Kennicott Water Softener is the correct, scientific application of a principle to the individual case.

Each installation is made under our direct, personal supervision, and only after a thorough investigation has proved conclusively that results satisfactory to you and to us can be obtained.

KENNICOTT WATER SOFTENER COMPANY



KENNICOTT WATER SOFTENER

THE CONSUMERS COMPANY
Ice Manufacturers. Chicago, Ills.

Capacity, 5,000 gallons the hour. Treats Lake Michigan water. This company reports a saving of 16.63% coal. Cost of treatment, six-tenths cent per 1,000 gallons.

Guaranteed Results

EVERY Kennicott Water Softener is guaranteed to produce definite results before it is built. You know exactly what the machine will do, and what it will cost to do it, before you give your order.

And the order is conditioned solely and exclusively upon the fulfillment of our agreement in every particular.

You do not pay one cent until the Softener is installed, is in perfect working condition, and you *know,* from actual, practical test, that it is doing all that we claimed it would do, and that the cost of operation is within the limit of our guarantee.

We take all the risk.

Unless the Softener fulfills *all* our guarantees — don't pay for it.

That's our way of doing business.

It's a safe way for you.

And a sure way for us.

We *know* what the Kennicott System will do.

We want *you* to know what it will do *for you.*

KENNICOTT WATER SOFTENER

DECATUR BREWING COMPANY
Decatur, Illinois.

Capacity, 500 gallons the hour. Cost of treatment, one cent per 1,000 gallons.

The Final Test of Merit

KENNICOTT Water Softeners are now in use on twelve railroads, beside numerous industrial plants and power houses are treating over twenty-six million gallons of water daily, and are removing therefrom over *nine thousand TONS* of scale-forming minerals each year.

The Union Pacific Railroad has used the Kennicott System for over three years. Its first order was for one softener; its second order was for ten softeners; its third order was for twenty-five softeners. Our first order upon the Pittsburg & Lake Erie Railroad was for one softener; the second order was for nine softeners. These orders being given only after a most careful and rigid investigation of the different systems of water softening proposed and in use. The investigation in question resulting in the unqualified endorsement of the Kennicott System—both as to extent of purification and ease and cost of operation.

These facts are proof of the genuine merit of the Kennicott System.

But the final test of merit *for you*, is the installation of one or more of these Softeners at *your* plant or on *your* road—where you can see with your own eyes and learn for yourself exactly what it will do, and how much money it will actually save, year in and year out.

That is the test to which we invite you to put the Kennicott System.

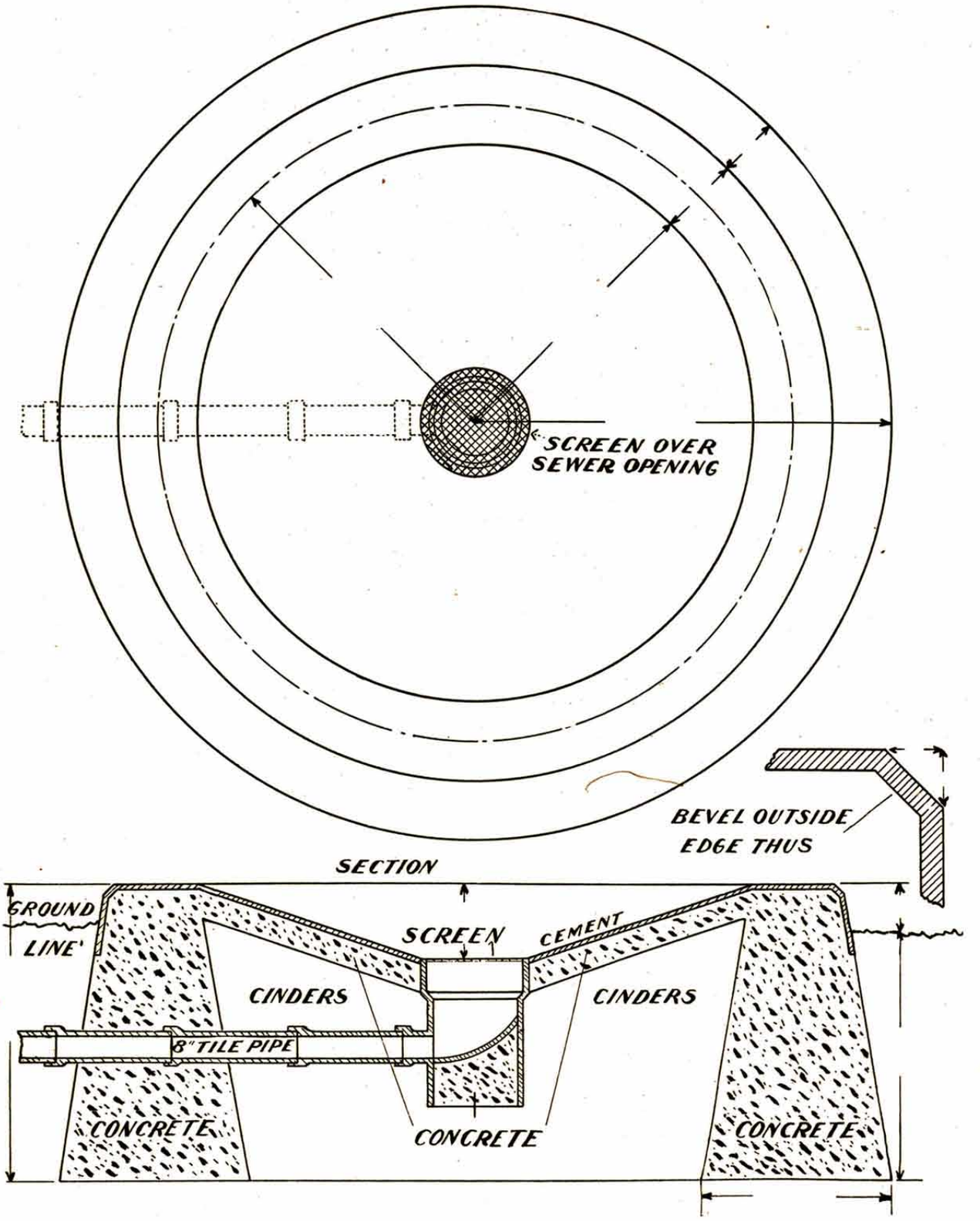
We stand *all* of the expense.

You receive the benefit.

We will gladly build the Softener.

Will *you* make the test?

KENNICOTT WATER SOFTENER COMPANY



FOUNDATION FOR KENNICOTT WATER SOFTENER