WYCKOFF

WOOD PIPE

ELMIRA, NEW YORK
·U·S·A·

Wyckoff Wood Pipe

Catalogue No. 32

Machine Made Wood-Stave Pipe

—For—

Water Works Systems, Power Plants, Mill and Manufacturing Plants, Mining and Railroad Water Supplies

—Also—

Wyckoff's Water-Proof Patent Steam Pipe Casing

—For—

Underground and Exposed Steam and Hot Water Pipe

A. Wyckoff & Son Company

Elmira, New York, U. S. A.

Pittsburg Office: Pittsburg Terminal Warehouse, Pittsburg, Pa.

The Original Manufacturers of Wood Water Pipe

WE make but one grade of goods—the BEST that can be produced, as to Design, Mechanical Construction, Material and Workmanship. We make Wooden Pipe for every purpose, and any size up to 48″ inside diameter

1855 1912

Introduction.

IN presenting this catalogue, No. 32, to the public we have not attempted to present a full and exhaustive treatise on wood-stave pipe. In explaining its products to prospective purchasers, we have found a constantly increasing interest evinced in the practical problems involved in the use of wood-stave pipe, especially as they relate to its economic features. The result of the many investigations of wood-stave pipe, which cover a period of many years, are scattered through a mass of periodicals, technical journals and manufacturers' catalogues, and are thus very difficult to reach by the busy engineer, water superintendent, municipal officer or manufacturer. In this catalogue such results have been briefly set forth in such shape as is believed will be useful and instructive to all those who may be interested in the purchasing and laying of conduits for carrying water of all kinds and for all purposes.

In 1855, A. Wyckoff of Elmira, N. Y., obtained letters patent upon boring machines for boring wood pipe from the solid timber and began the manufacture of wood pipe. This pipe, at first only locally used, soon made its merits known, and the market rapidly expanded. Mr. Wyckoff sold the right to manufacture the pipe for the use of water-work systems, and a few manufacturers began to supply it for that purpose, but he turned his attention to supplying the mining districts of Pennsylvania, and elsewhere, with the wood-pipe, recognizing that there, at least, he could defy competition, as it had been found that cast iron, wrought iron or steel pipes quickly gave way under the deteriorating influence of the acids contained in the waters from the mines. The use of wood-stave pipe of large diameters for use as water supply mains, both to municipalities and water power developments throughout the eastern state, pushed our company into the manufacture of wood-stave pipe up to 48 inches in diameter and up to a pressure of 172 pounds per square inch. This required the erection of a new and larger plant, with larger and more modern machines. It also led to the erection and equipment of a testing laboratory in which experiments have been made under the direction of a well known hydraulic engineer, to determine the proper thickness of metal and spacing of bands to withstand the several pressures to which the pipe may be subjected; the elongation of the steel bands due to pressure and swelling of wood; the loss of water due to seepage; the proper joint to prevent leakage; the best coating to prevent oxydation of steel bands, and many other useful and necessary points to be known before turning out upon the public a finished product. Our company own and operate the largest and best equipped wood-pipe factory in the world, and are prepared to promptly supply all orders for such pipe up to forty-eight inches in diameter, and steam-pipe covering up to thirty inches in diameter.

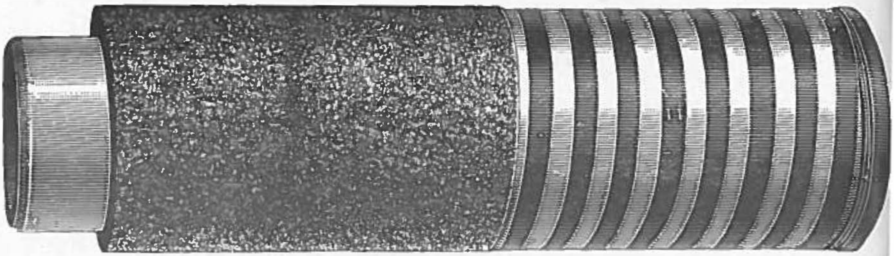


PLATE NO. 1.

Showing Wood Stave Pipe for low pressure.
Protective Coating omitted from one half of pipe to show steel bands. Note double winding at end.

Wood Pipe.

FOR centuries past wood pipe has been used as a means for conveying water. Long before cast iron pipe was made, public water supplies had been built in which the supply mains and distribution system consisted of wood pipes. In Rome the old sheet lead pipes were taken out many generations ago and wood pipe substituted therefor. The first water supply of the City of London had lead and wood mains, the former having been taken out and wood used to replace them. Boston, Mass., built the first public water supply in America in 1652, and the mains consisted of wood pipe, which were largely replaced with wood again in 1796. These were, for the most part, taken up about 1848, and cast iron pipe substituted. The first water supply of New York City was built with wood pipe as distributing mains. The City of Philadelphia built its public water works about 1799, and used not only wood pipes for its distribution mains, but wood fire hydrants, wood pumps and wood boilers. These wood pipes consisted of spruce pine logs bored out, mortised and tenoned at ends, with wrought iron bands fastened around each end. Many of these were in continuous use until 1844. Some were removed about 1819 and 1820, and sold to Burlington, New Jersey, where they were again used as water mains in the latter system, which had been built with wood pipe in 1804. The City of Wilmington, Del., laid wood water pipe about 1816, and many of them are still in the ground.

Cast iron water pipe was first made in America by Mr. Samuel Richards at Philadelphia in 1819 or 1820, and sold to the City of Philadelphia to extend its water system and to replace the old wood pipes

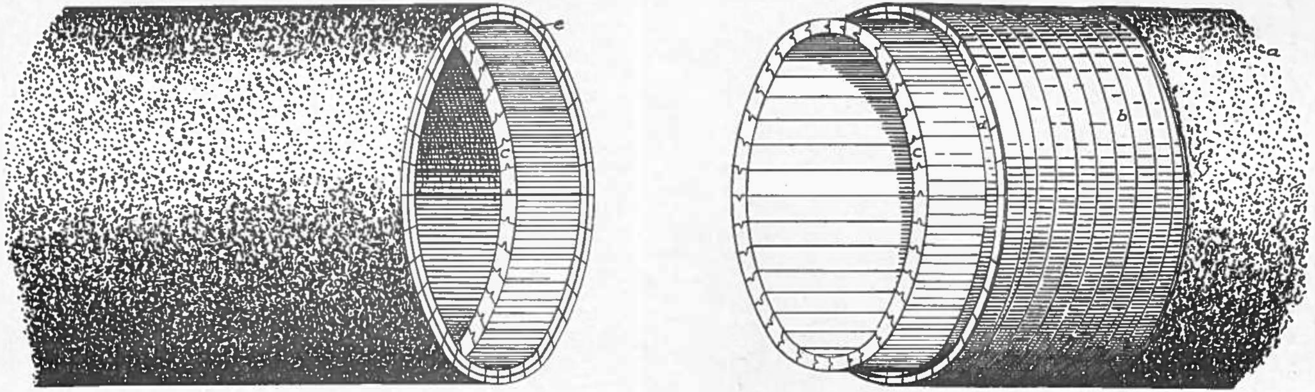


PLATE NO. 2.

Showing Two Ends of Wood Pipe.

a — Hydrolene-B Coating.
b — Steel bands, wound solid for high pressure.
c — Ends of tenon and shoulder.

which had not sufficient capacity to supply the increasing demands. At this early date the capacity of a wood pipe depended upon the diameter of the log from which it was made, the diameter of the bore rarely exceeded six inches, more frequently three and four inches, therefore when it was found that cast iron pipe could be cast to an inside diameter of eight, and even to ten inches, the problem of larger supplies with one line of pipe was practically solved, and from that time until steel pipe was manufactured, cast iron pipe was universally used for water pipe.

As the Pacific Coast States were developed and water supplies were demanded, the cost of transporting cast iron pipe from the East was so great, and the obstacles were so insurmountable, that cast iron pipe was practically prohibitive to the greater number of municipalities and water development promoters. Inexhaustible forests of pine, redwood and fir were at hand, and these were attacked to again make wood pipe, not by boring out the logs, as in more ancient days, but by working up the logs into staves of uniform width and thickness and banding these together by steel or wrought iron, thus producing a pipe of any desired diameter and to withstand any required pressure. These staves being planed on both sides to a circle corresponding to the diameter of the pipe to be laid, the edges cut radial to the circle and with a bead left on one edge, were shipped to the point where they were to be laid, and there built up into a continuous pipe by banding the staves together on the outside with round wrought iron or steel circular rods, which were clinched up until the longitudinal joints were in perfect contact throughout. The thickness of the wood staves were made from 1⅜ inch to 1⅞ inch, and the bands were spaced to conform with the pressure which the pipe was expected to withstand. The wood pipe made as thus briefly described is known as "Continuous wood-stave pipe."

Manufactories were established in the East and on the western coast to make wood-stave pipe complete in the factory. It was found that the laying and banding of the wood pipe below 24 inches in diameter in a wet trench was a tedious and difficult operation. That if these smaller sizes could be made in the shop and shipped in sections ready to put together, the whole cost would be less and the results obtained more satisfactory. The Western Coast factories used a drawn iron or steel wire, spirally wound under high tension, to band the pipes made by them, whereas the factories in the East, of which the Wyckoff Company is the largest, banded the staves together with a flat steel

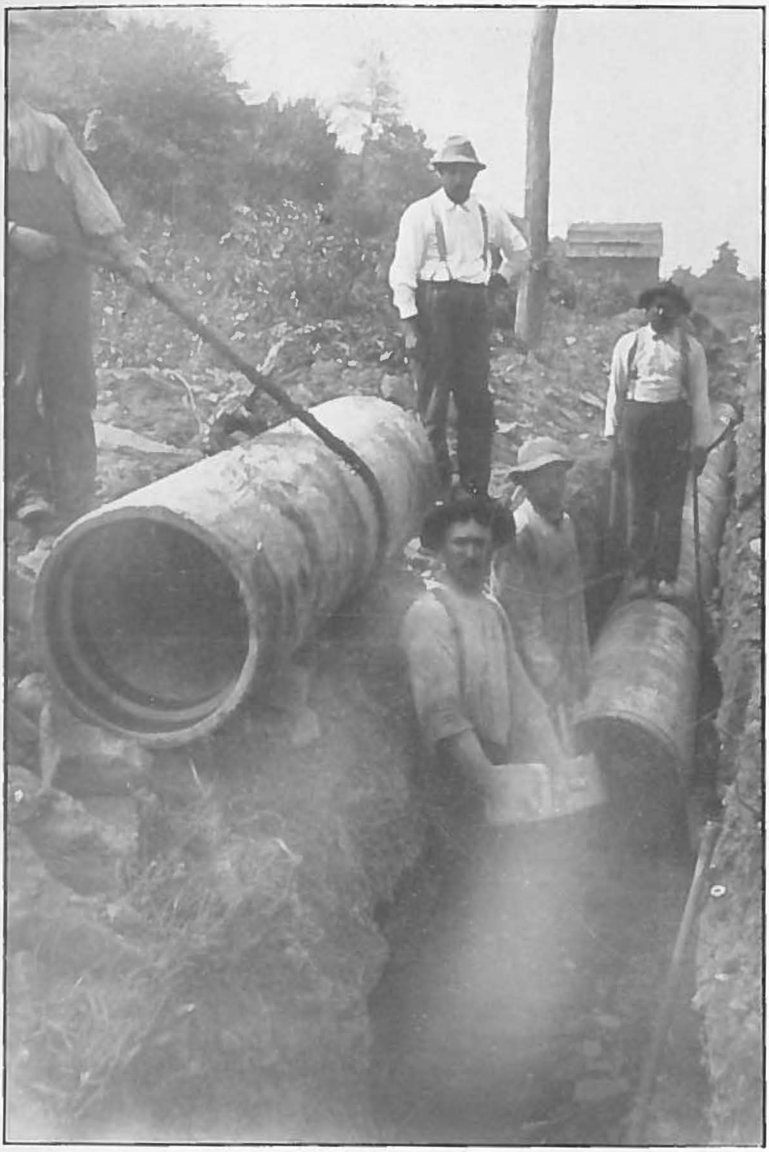


PLATE NO. 3.

Laying 20 inch Wood Stave Pipe at Austin, Pa.

band, spirally wound under sufficient tension to draw the staves tightly together. This character of pipe is called "Machine made wood pipe."

These wood pipes (both continuous and machine made) were found to give such unexpectedly good results wherever used by those familiar with the principles involved, that engineers and others interested in building and operating water works in the eastern states have realized that wood stave pipe has a practical and economic value among the standard types of water pipe, and when the correct principles involved in its successful and economic use are better and wider known it will be universally specified by those who are familiar with these principles.

We do not claim that wood pipe should be preferred to cast iron pipe under every and all conditions. We do not believe wood pipe should be used when the normal or constant pressure exceeds 172 pounds, and there are other conditions under which we would recommend the use of cast iron in preference to wood. But where there is a supply main, connecting the source of supply to the consumer, or to a reservoir, and this supply main is kept full and constantly under pressure; where there is a supply main from the pump to reservoir or consumer, where the pipe is kept full of water; where penstocks are required with water under head, or where water highly charged with acids which tend to destroy iron must be piped, we claim that our machine made pipe is quite as durable as cast iron, more durable than steel, can be laid at much less cost, is as cheaply maintained and can carry much more water with equal diameter.

Durability.

By those familiar with the properties of the softer woods, it is known and admitted that these woods when subjected to complete saturation will last longer than we have any knowledge of. Most engineers and contractors who have had to do the underground work in the older cities of the Eastern Coast, have encountered old wood pipes which had been buried in the ground generations ago, and have been surprised to find them in a perfect state of preservation, except for a mouldy, damp rot upon the surface. In 1898 some of the original wood pipe laid in the London water works in 1802 were taken out sound and free from rot. Some of these wooden mains were in actual use as late as 1865, after having been in the ground for 63 years. The wood pipes first laid in the City of Philadelphia were in continuous use many years, and some, after being in use there for 21 years, were removed and relaid in Burlington, where they were in continuous use

PLATE NO. 4.

Laying 12 inch Wood Stave Pipe at Canajoharie, N. Y.

for 28 years. It may be said by the doubting ones that these pipes were all logs, not sectionally made, and that the life of the wood represented the life of the pipe, but in reply we would call their attention to the fact that there were usually two wrought iron bands at each section, and if these bands rusted through the pipe would leak, but leaving these old log pipes out of the question, when considering the durability of the more modern made wood pipe, we would call your attention to many well known examples of the durability of wood-stave pipe as at present manufactured. In 1862 the City of Victoria laid a distribution system of wood stave pipes which was in constant and successful use until 1901, when they were removed to give way to pipes of larger capacities. Elmira, N. Y., laid wood stave water pipes manufactured by A. Wyckoff in 1860, several miles of which are still in daily use under pressure ranging from 35 pounds to 86 pounds. In late years these pipes have been examined at many salient points, and in every case were found to be in excellent condition with no leaks apparent. The water supply main for Quincy, Ill., was partially laid as a submerged main in the bed of the river in 1887. It was thoroughly examined in 1906 and found in perfect state of preservation. There are over 100 miles of wood stave pipe in the water works of Denver, Col., many miles of which have been in continuous use under high pressure for over 20 years without apparent diminution in service. These pipes are buried in the ground under the streets and are subjected to the same conditions as are usual in distribution mains. The Wyckoff Wood Pipe has been furnished to cities, towns and villages, to hundreds of corporations operating mines, railroads, tanneries, water powers and other manufactories, and many miles of this pipe have been in continuous use for 40 years. J. T. Fanning in 1874 built a 72-inch continuous wood-stave pipe in connection with a water power plant at Manchester, N. H.; in 1903 this pipe, which had been in continuous use, was in excellent condition, and had required no repairs. We could go on page after page citing instances of the durability of wood-stave pipe, but we believe we have given sufficient facts to convince any reasonable person. We admit that there have been a few failures in wood stave pipe due to an unfamiliarity with the principles involved in its use. We could also cite many failures of cast iron and steel pipes due to the same cause. Each kind of pipe has its proper place and we believe it is for the competent hydraulic engineer, who may be familiar with the three kinds, to determine that which should be used in each case.

PLATE NO. 5.

Laying 20 inch Wood Stave Pipe at Akron, Ohio.

Under the usual conditions, it is conceded by those familiar with the subject that the life of the wood stave pipe depends upon two things; first, the necessity of keeping the pipe under pressure, such as will thoroughly saturate the wooden shell, and secondly, the life of the iron or steel bands surrounding the staves. Our wood-pipe is made from the best obtainable Canadian pine, selected, free from sap and black knots. This is a soft wood susceptible of easy saturation. When put under pressure the outside of the pipe is damp at all times and the penetration of water is complete. The band used is coated during the winding with a protective coating of Hydrolene-B which thoroughly coats both faces of the band, as hereinafter described. In addition to this, after the pipe is wound, it is placed upon rolls which revolve through a hot bath of the same kind of coating, which adheres to the outer face of the wood and steel, effectually protecting them from the decomposing and oxydizing influences contained in the water and in the ground through which the pipe is laid. We have found after 20 years of observation that this coating does completely and satisfactorily protect the steel and wood, and as long as this result is obtained we claim to have indestructable pipe.

Ability to Withstand Pressure.

In approaching many engineers and water works men who are unacquainted with the mass of printed data concerning wood stave pipe, we have been repeatedly told that they have no doubt as to the durability of the pipe, but they do seriously doubt its ability to successfully withstand pressures of from 50 to 172 pounds. In opposition to this doubt we would like to call attention to a few well known wood stave pipe lines and the pressures which are constantly put upon them.

Windber, Pa., Water Company	24 inch	250 foot head
Windber, Pa., Water Company	20 inch	250 foot head
Norfolk County Water Works	24 inch	200 foot head
Butler, Pa., Water Works	24 inch	200 foot head
Riley, Me.	16 inch	200 foot head
Lee, Mass.	28 inch	200 foot head
Jaffrey, N. H.	30 inch	200 foot head
Houtzdale, Pa.	8 inch	300 foot head
Elmira, N. Y., Water Works	16 inch	170 foot head
Canajoharie, N. Y., Water Works	12 inch	270 foot head
Swanton, Vt., Water Works	12 inch	270 foot head
Akron, Ohio	20 inch	170 foot head

All of the above mentioned pipe lines are Machine Made and

PLATE NO. 6.

Laying 24 inch Wood Stave Pipe at Windber, Pa.

manufactured by A. Wyckoff & Son Company and many of them are operated under such conditions that they must stand pressures much in excess of the normal, this excess being due to water hammer. The Wyckoff Pipe has been used for many years, as pump mains in lines in the anthracite region where the pressure exceeds 200 lbs., and no complaint has ever been heard that they do not work successfully. At our testing plant we have subjected the several sizes of pipe, solidly wound, to 270 lbs. pressure, without rupturing the pipe or causing serious loss by leaking or by weeping. Before shipping any pipe for high pressure random lengths are subjected to the required pressure to ascertain whether they have been properly manufactured.

Electrolysis.

This enemy to cast iron and steel pipes has caused the water superintendent and engineer many sleepless nights and has cost owners of water works thousands of dollars. Electrolytic corrosion of cast iron and steel is widespread and many suggestions have been made by scientific men to overcome the difficulty, but one of the most unique methods used was at St. Johns, N. B., where the joints between the cast iron mains were made with wood wedges driven tightly in the space usually occupied by hemp and lead. This kind of joint was adopted in 1851 as being cheaper and better than lead, and it proved so durable that in 1899 the same kind of joint effectually prevented electrolytic corrosion. Wood is a non-conductor, and so are the commercial products of aspnalt. In making the "machine made" wood pipe the steel bands are so thoroughly covered with the asphalt protective coating that the entire conduit becomes a non-conductor. This is one of the advantages of using wood stave pipe which appeals to those water works men who have appreciated the losses realized from electrolysis.

Frost.

In laying a long supply main the expense of excavating the trench, especially where rock is encountered, becomes an important question to consider. If the main is laid with cast iron or steel, a wise engineer will bury it below maximum frost line, unless there is at all times a high velocity of flow to be maintained in the pipe. Throughout the Northern and Northeastern section of the United States, and in Canada, the frost line extends to a depth of five, six or seven feet. Wood pipe, being a non-conductor of heat and cold, can be laid one foot under the ground without fear of its being damaged by the water freezing

PLATE NO. 7.

Showing photograph of 24 inch Wood Stave Pipe laid at 300 feet radius, at Carney's Point, N. J., for E. I. duPont Powder Co.

inside the pipe. Thus a large portion of the expense of laying cast iron or steel pipe may be saved by using wood.

Carrying Capacity of Pipes.

The carrying capacity of pipes has been determined with more or less accuracy, by experiments made by many scientific investigators, and covering many actual and supposed conditions. In reducing these experiments to a formula for ready use a value has been given to the roughness of the wetted surface of the conduit, this roughness being represented by the letter "N," the rougher the wetted surface the less the capacity of the pipe. This value of "N" has been found to vary from 0.0115 for new cast iron pipe to 0.020 for tuberculated pipe; from 0.0115 for new steel riveted pipe to 0.017 for steel pipe in use for 14 years or more, and from 0.011 for new wood stave pipe to .0096 for wood pipe in use for ten years. In every recorded experiment made to ascertain the carrying capacity of iron or steel which had been in use for a number of years, it was ascertained that the value of "N" had largely increased, whereas experiments upon old wood stave pipe showed the reverse. The cause of the diminished capacity of the iron and steel is the gradual formation of nodules of rust or tubercles, and the accretion of various organic growths on the inner surface of the metal. On the other hand we know of no case, where a wood pipe has been kept full of running water, that its inner surface is rougher after use than when first laid. We have, at much trouble and expense, had a full set of tables appended to this catalogue which shows at a glance the advantage of using wood stave pipe so far as the relative carrying capacity is concerned. These tables are here presented in the hope that they may be of service to both engineers and water superintendents in determining the size of pipe to specify under certain conditions.

Below are two tables which show the comparative velocities in feet per second and discharging capacities in gallons per minute for a 16 inch wood, cast iron or steel pipe with heads of from 1 to 6 feet. It will be noted here that a 16 inch wood pipe can carry 14-5 per cent. more water than cast iron, and 20 per cent. more than steel. These percentages are somewhat in excess of those found by Mr. Arthur L. Adams, as noted below, but our experiments indicate them to be correct.

PLATE NO. 8.

Showing 16-inch 100-pound pressure Wood Stave Pipe crossing railroad bridge for International Paper Co., Riley, Maine.

Table 1 Showing Comparative Velocities in Feet Per Second in a 16″ Pipe, 1000 Feet Long Made of Different Materials Under Various Heads.

Head in Feet	1	2	3	4	5	6	Average Per Cent
Wooden	2.35	3.33	4.07	4.70	5.27	5.76	100.0
Cast Iron	2.01	2.84	3.48	4.02	4.50	4.94	85.5
Riveted Steel ..	1.88	2.66	3.27	3.77	4.21	4.62	80.0

Table 2 Showing Comparative Discharging Capacities in Gallons Per Minute of a 16″ Pipe Under Different Heads and Made of Different Materials.

Head in Feet	1	2	3	4	5	6	Average Per Cent
Wooden	1477	2086	2552	2940	3300	3615	100.0
Cast Iron	1262	1782	2183	2522	2821	3041	85.5
Riveted Steel ..	1181	1694	2050	2362	2637	2396	80.0

Mr. Arthur L. Adams, a leading hydraulic engineer of the Pacific slope, writes, in a paper presented to the American Society of Civil Engineers under the date of June, 1899, as follows:—"Clean cast iron pipe would seem to have about 90 per cent. of the carrying capacity of a stave pipe, while if seriously tuberculated, a condition which usually prevails after a few years of use, they discharge only about two-thirds as much as stave pipe of the same size. The steel pipe discharges when clean, from 93 per cent., in case of twelve inch pipe, to 68 per cent., in case of a 6 foot, of the amount which might be expected from stave pipes of the same diameter, while if steel pipe is tuberculated to an extent that may readily occur in from ten to fifteen years use, these discharges may fall to 74 per cent. and to 54 per cent. respectively."

"Omitting other considerations, is not the value of a pipe line investment proportional to its delivering capacity? Do not these percentages, then, represent approximately the relative values of these different classes of pipe as investments."

We believe this to be a pertinent query, and would suggest to any engineer or water works man the advisibility of estimating the relative value of his client's, or his own investment, taking into consideration

PLATE NO. 9.

Laying 24-inch Wood Stave Pipe at Thurmont, Maryland.

the cost of laying each class of pipe, its carrying capacity and the interest on the investment, the results we are sure will convince him of the desirability of using the wood stave pipe, where conditions are favorable. As a sample the following table is submitted, based on six per cent. interest compounded annually on the difference between the cost of furnishing and laying cast iron and wood-stave pipe, exclusive of trenching. Prices stated below are approximate only.

Cast iron at $30.00 per ton.

Table 3.

Size	Wood	Cast Iron	Dif. in Cost	The Interest on Difference in Cost Will Rebuild Wood in
12 inches	$0.82	$1.64	$0.82	11.4 years
24 "	1.65	4.61	2.96	7.6 "
36 "	2.72	8.88	6.16	6.3 "
48 "	4.25	14.00	9.75	6.2 "

Thus in the case of a 24 inch pipe, if the wood lasted but 8 years, and then had to be relaid it would then be a better investment than cast iron. We claim, however, and with just cause, which we hope we have already proven to any reasonable man, that the life of the wood pipe is equal or almost equal to that of the cast iron.

Coating.

As previously stated, when wood pipe is laid under the proper conditions its life depends upon the life of its steel bands, and the life of these depends upon the absence of corrosion. If this can be prevented of course the steel will last a long time. Our company has experimented for years to ascertain the best mixture for a protective coating. The qualities required are as follows:— It must be durable, hard, tough, perfectly water-proof and strongly adhesive to the metal. It must show no tendency to flow under summer temperature and must not become brittle so as to crack or scale, under freezing temperature.

This material is known as Hydrolene-B and the well known firm of chemists, Dow & Smith of New York City, report to us on this material as follows:

"Hydrolene-B is a solid bitumen produced by distilling Texas oil or Texas oil residuum and at the same time blowing air thru the heated oil. The oxidizing effect in the air turns the liquid residuum into a solid. The different grades of Hydrolene are produced by more or

PLATE NO. 10.

Laying 12-inch Wood Stave Pipe at Swanton, Vt.

less oxidation and prolonged distillation. Properly manufactured Hydrolene-B should have a long life underground and from our present knowledge and actual experience we know that it has endured practically unaltered for a period of six years. The characteristic properties of Hydrolene-B and like products are that they are but little susceptible to changes in temperature; that is, they are not rendered brittle by cold but remain rubbery and pliable. While at high temperatures they do not soften so much as to become sticky nor will they melt as to flow even at the highest atmospheric temperature. In this property they are far superior to all asphalts and coal tar pitches. It is an excellent preservative of steel and thoroughly protects it from moisture and corrosion underground. Of this we have a practical demonstration extending over a period of many years. We would advise you to use Hydrolene-B for coating your pipe."

The manufacturers of this material make the following claim:

"As to its permanency, we know this material is practically indestructable and underground especially should it be so. None of this material has ever been known to disintegrate and a chemical anaylsis of it will show that the volatile matter is so small as to prevent any disintegration."

The coating is heated in tanks by steam to a temperature of between 250 degrees and 300 degrees fahrenheit and applied to the steel bands as it is being wound around the wood, by running the band through the tank which stands upon the winding machine; this method insures a full and complete coating between the steel and the surface of the wood, thus preventing the moisture which may seep through to the outside of the wood from coming into direct contact with the steel bands.

After winding, the chambers and tenons are cut on the pipe, each being four inches in depth by one half the total thickness of the shell of the pipe, which is usually 1⅞ inches thick. After leaving the finishing machine the pipe is placed on the top of two grooved rollers, set parallel and horizontal, with one half their diameters submerged in a tank of the hot Hydrolene-B, as before described. As these rollers revolve the pipe revolves, and the coating which adheres to the rollers is thus applied to the outside surface of the pipe, covering the bands and wood. After all is applied that the surface will hold, the pipe is rolled on to a table filled with saw-dust, the saw-dust adheres to the hot coating, and protects it from being knocked off or abraised in shipping or laying. When conditions require we recoat the pipe by running

PLATE NO. 11.
Coating Machine.

it a second time over the rollers and through the saw-dust, thus getting a protective coating over the whole surface of the pipe from ¼ inch to ⅜ inches thick. A photograph of the coating machine is shown by Plate No. 11.

Some authorities have claimed that the wood is more durable, if not covered by any protective coating, but our observations and experiences have shown, most conclusively, that this is not true under the majority of conditions existing underground. Decaying organic matter, especially when in combination with certain minerals common to most ground, like iron, sulphur and copper, does have a decomposing effect upon the outer skin of the wood, unless the pipe is thoroughly saturated throughout under high pressure. We could cite many convincing proofs of this which have come under our own notice in 57 years of business experience, and many well authenticated records of others.

Special Features in Manufacture.

As hereinbefore mentioned the wood from which our wood-stave pipe is made is selected Canadian pine. As the staves are run through the finishing machine, which cuts the double groove and tongue and planes the faces to circular and radical lines, a competent inspector of many years experience handles every stave just at the time when its defects can best be detected. This inspector culls out about fifteen per centum of the timber which comes to our factory and these culls are used for other purposes foreign to wood pipe. The winding machine used for banding the wood staves together is so arranged that the band can be wound at any desired tension, according to the set of the machine, which is regulated for each class of pipe according to diameter and pressures specified. The tension can be made great enough to crush the wood in the large size pipe. During the manufacture of one standard a uniform tension and spacing is absolutely assured.

The chambers and tenons are necessarily cut uniformly by a machine so that every joint between two pipes must fit as the knives and heads are set alike for each size pipe.

The pipes are made in maximum lengths of 12 feet. We have found that sections of 12 feet require a minimum expense in handling, at factory, loading and unloading in and from box cars, by which means they are always shipped, hauled to work and building along the conduit line. The shorter sections permit of the pipes being laid in a curve with perfect satisfaction. The Plate, No. 7, shows a photograph of a 24 inch wood pipe of our make, laid at Carney's Point, New Jersey,

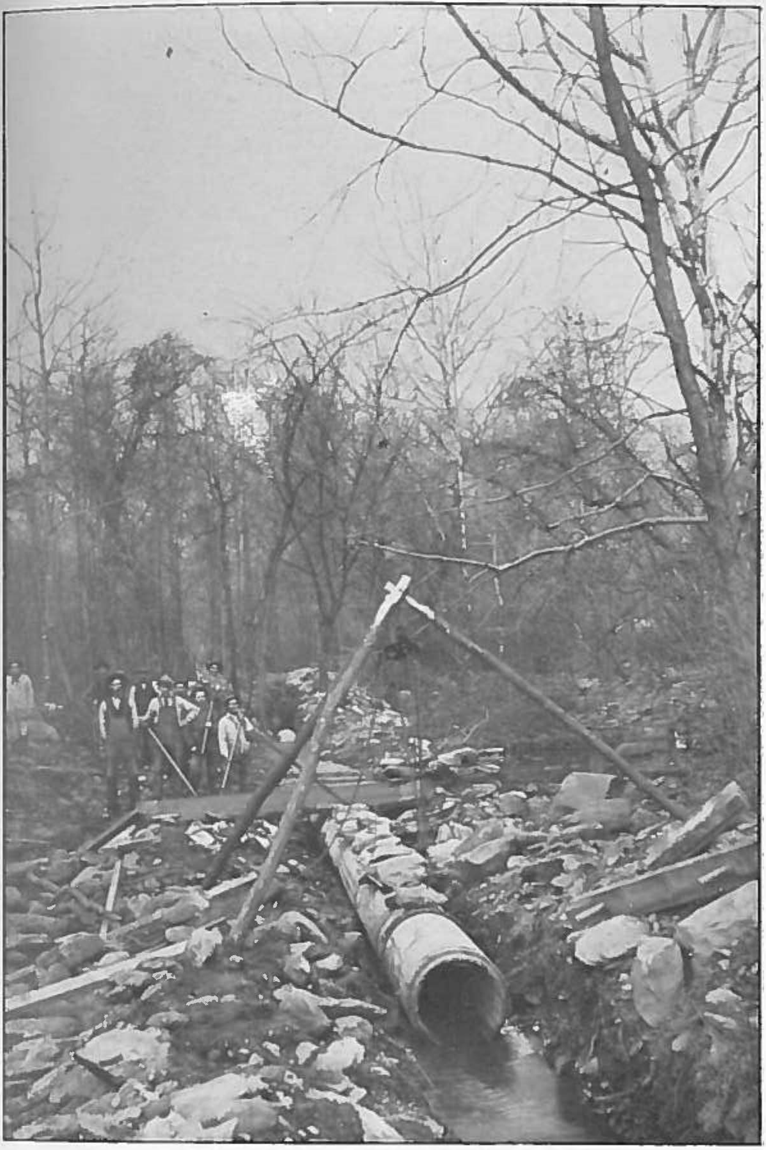


PLATE NO. 12.

Laying of 20-inch Wood Stave Pipe at Thurmont, Maryland.

on a radius of three hundred feet; the engineer in charge, Mr. J. L. Warner, stated to us that he could have laid it just as easily and satisfactorily at a 200 feet radius. As each stave is made two grooves are cut into one edge ⅛ inch deep and ⅛ inch wide at the base of groove. On the opposite edge two tongues or heads are cut 3-16 inch high and 3-16 inch wide at base of head. Each of these is cut ⅜ inches from the outer and inner face of the stave. When the staves are banded together the head, being a little larger than the groove, is squeezed into it and thus makes a thoroughly water tight joint. The shorter sections of pipes are always used to make up the curves.

Advantages in Laying Wood Stave Pipe.

There are many advantages gained in the actual work of laying machine-made wood-stave pipe over the laying of any other kind of pipe. Some of these may be mentioned as follows: The cost of transporting over rough country or through muddy road; the pipe being light a large number of feet can be hauled over the worst roads. It can be unloaded from the cars without the use of derricks, or other machines, and can be handled with few men. It can be laid in the trench with unskilled men, and without the use of tripods or derricks. There being no joints to make, rivets or bolts to place, the perfection of joints can always be assured. The shoulders of the two pipes being cut to fit precisely, the grade, alignment and perfect seating of pipe can be determined by the inspector or foreman on top of the trench by simply observing whether the shoulders of the two pipes are in contact throughout the upper half diameter of the pipe. When the pipe is laid through wet trenches, the water need not be entirely removed, as is the case in any other kind of pipe laid. The water can remain in the trench to a depth of one-half the diameter of the pipe and yet the work can be done with perfect satisfaction. Plate No. 12 shows a photograph of the laying of a 20 inch pipe at Thurmont, Md., where the water in the trench was 10 inches deep while the pipe was being laid, and yet the work was done to the satisfaction of the engineer in charge, and the pipe was laid with 8 unskilled men just as fast as the trench could be prepared, which in some cases was at the rate of 800 feet per day of 10 hours.

The following table shows detailed information concerning the transportation, hauling and laying of machine-made wood-stave pipe under the average conditions, and can be used with safety by contractors who are submitting propositions for work of this character.

PLATE NO. 13.
Laying 12-inch Wood Stave Pipe at Canajoharie, N. Y.

Table 5.

Showing Dimensions, Data of Transportation, Hauling and Laying of Wyckoff Wooden Pipe.

Size of Pipe in Inches	Outside Diameter of Pipe in Inches	Weight Per Lineal Foot in Lbs. 80 Lbs. Pres.	No. Feet in Carload 40′ Car	No. Feet 2 Horse Truck Can Haul	No. Men Used in Laying Exclusive of Forem'n	No. Feet These Men Can Lay in Day of 10 Hours
6	10⅛	15	2700	344	4	2000
8	12⅛	17	2300	272	4	1900
10	14⅛	23	1800	216	4	1700
12	16⅛	25	1500	192	6	1500
14	18⅛	31	1100	152	6	1400
16	20⅛	33	900	144	6	1200
18	22⅛	38	750	128	6	1000
20	24⅛	42	500	112	6	800
24	28⅛	55	330	80	8	600
30	36⅛	90	225	64	8	450
36	42⅛	120	160	48	8	300
48	54⅛	150	95	24	8	200

Comparative Cost.

The cost of laying machine-made wood-stave pipe is far less than that for laying any other class of pipe used for carrying water under pressure. This is made possible because there is no special labor or extra materials used in making the joints. The width of excavation is much less because no joints are to be made and it is not requisite that men should get around the pipe in laying it. The pipe is light enough to permit of being laid in the trench without the use of a slow moving block and fall. Even a 48 inch pipe can be lowered and fitted by 8 men, with four rope slings, and 6 of these men can drive the pipe home. In wet trenches the cost for pumping is much reduced for reasons already mentioned.

The comparative table on opposite page has been prepared with great care, and is compiled from the actual contract prices given from time to time for work where the average conditions existed. The cost of labor has been assumed to be $1.75 per day.

Machine-Made vs. Continuous Wood-Stave Pipe.

There are many advantages which machine-made wood-stave pipe has over continuous wood-stave pipe which might be mentioned from the viewpoint of practical experience. First and foremost is the

Table Showing Approximate Cost of Laying Pipe.

(Excluding Hauling, Excavation and the Pipe Itself.)

Size Pipe, inches	4	5	6	8	10	12	14	16	18	20	24	30	36	48
Wyckoff Wooden	0.01	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.06	0.07	0.08	0.10
Steel Riveted	....	....	....	....	0.30	0.30	0.32	0.34	0.36	0.41	0.48	0.60	0.82	0.91
Cast Iron Inc. Lead and Hemp	0.09	....	0.14	0.18	0.21	0.25	0.27	0.37	0.39	0.51	0.64	0.80	1.09	1.30

Lead and Hemp at 5 cts. per pound.

uniformity with which machine-made pipe can be produced. From the selection of the lumber to make the staves to the loading of the pipe on board cars, it passes through the hands of workmen who have had years of experience in selecting the lumber and making the pipe. It is built under comfortable surroundings, where men can work regularly and therefore do their best; the banding is done by machines which make it absolutely uniform and where every foot of pipe is alike. It can be laid in the wettest kind of a trench by men standing deep in muck and water. Cold, warm or wet weather has no effect upon its satisfactory progress, and the trench can be filled in immediately after the pipe is laid.

On the other hand, any one who is familiar with the laying of continuous pipe knows that it bears constant watching on the part of the inspector or foreman to prevent defective staves from forming a part of the pipe; that the length of the staves selected and placed along the trench for the builders rarely suit the latter without being picked over two or three times. That in shipping, or for other reasons, the ends of many staves get cracked, slivered or otherwise damaged and have to be sawed off and new saw kerfs cut in the end, which are frequently not done with sufficient accuracy as to fit the end of the next stave. That great care must be taken to get the metal tongues placed in their proper position as each stave is driven in place. That the spacing of the bands must be watched closely and even then it is not regular. That the bands are not always bent to a uniform circle, and this requires more careful coopering of the pipe, which in small diameters where the men are confined in an uncomfortable position, and in frequent cases stooping in water, is hard to secure. That in the placing of the bands the protective coating does get knocked off in places. That the water and muck must be removed from the trench before the pipe can be well built. That the trench must be excavated at sufficient width to allow men to stand on each side of the pipe. That it is impossible to get a uniform tension on the bands as it is done by hand by many different workmen, and there is no way except by the personal equation to know when the bands are uniformly cinched, and that the final cinching of the bands cannot successfully be done until they have been in position for a day or more. All of these reasons are real and none of them are encountered in the laying of machine-made pipe.

The machine-made pipe can be successfully and satisfactorily made up to 48 inches in diameter, and be laid in a trench of any character, with less cost and better than continuous pipe.

PLATE NO. 14.
Laying 20-Inch Wood Stave Pipe at Bristol, N. H.

Advantages of Wyckoff Machine Made Wood Pipe.

The Wyckoff machine made wood pipe has been and is being successfully used for conveying water to municipalities for domestic and fire purposes. For conveying mine water, both hot and cold; for mine culm, tan liquors, mineral spring waters, brine, heavy fluids and pulps in fertilizer works, paper mills or provision factories, and also for conveying diluted sulphuric, nitric, muriatic, acetic and tartaric acids. Its special advantages may be summed up as follows:

Under proper conditions it is as durable as cast iron.

It is more durable than wrought iron or steel.

It is cheaper than either cast iron, steel or wrought iron.

Its carrying capacity at all times is greater than iron or steel.

By its continued use its capacity does not decrease, whereas that of iron or steel does decrease yearly.

It needs no skilled labor in laying.

It can be laid with less width of excavation.

It can be laid at less depth because it is not as readily affected by frost as is either iron or steel.

Prevents electrolysis.

Saves freight.

Is not corroded by the fumes and acids of many fluids.

Is not destroyed by sulphur or other impurities in minerals.

Does not taint water or contaminate fluids carried.

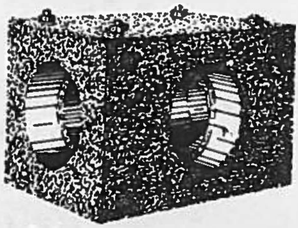
If frozen the elasticity of the wood retards bursting.

Can be laid in the wettest kind of trench.

Salt water does not affect it.

Fittings for Wyckoff Wood Pipe.

Wooden Crosses, Tees and Ells are made by properly boring heavy blocks cut from square timbers.



Wood Fitting, Coated

FIG. 1.

Tension bolts as shown in Fig. 1 prevent the block from splitting—the number and size of the bolts depending upon the pressure to be resisted. The openings are made of the same dimensions as standard

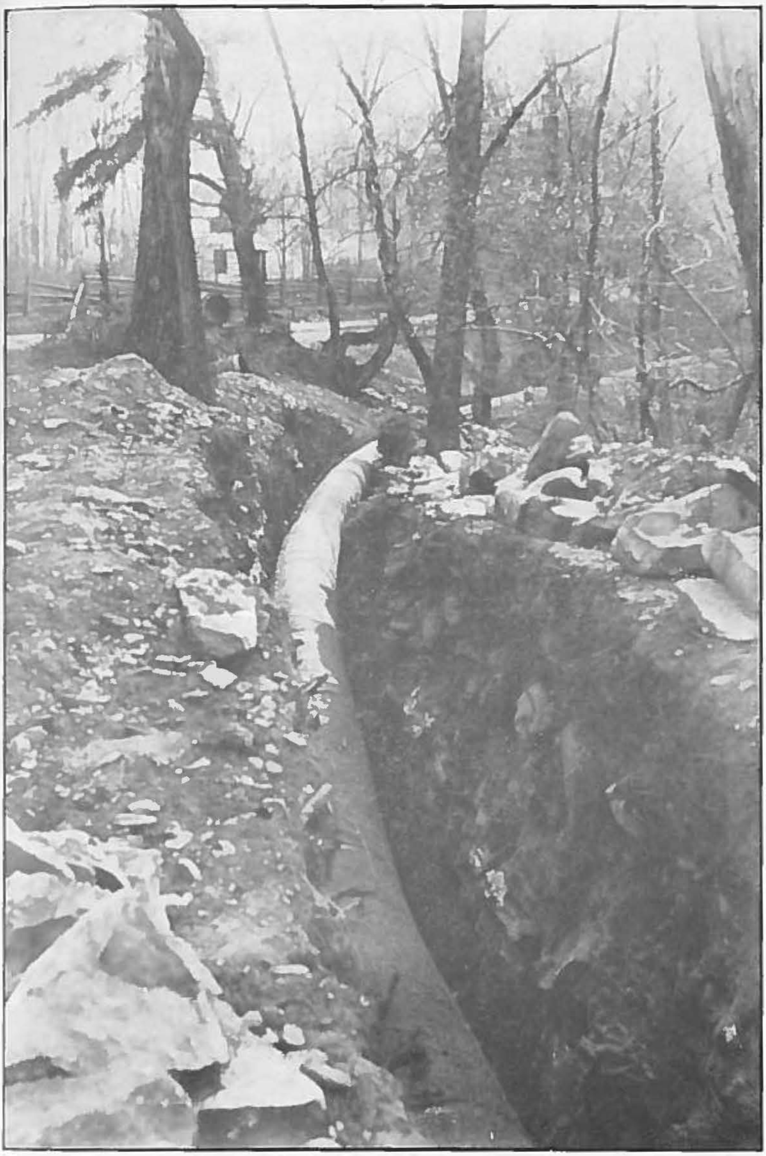


PLATE NO. 15.

Showing Curve on 24-inch Wood Stave Pipe at Thurmont, Maryland.

chambers, the connections being effected by using, immediately preceding the fitting, a special section of wood pipe having a tenon on each end. This special section is first driven into the fitting and the combination then handled exactly like a regular section of pipe. Or if especially desired the fitting may be provided with regular tenon and chamber in the "run."

Wood fittings are recommended where the water carries chemicals injurious to iron, or where it is desirable to maintain extreme purity in the liquid conveyed. They are impractical in large sizes or for highest pressure.

Special Cast Iron.

Special Cast Iron Fittings are most satisfactory for ordinary and general purposes. Fig. 2 shows in section an Ell of this style, and Fig. 3 is from a photograph of a Tee. It will be noted that these are

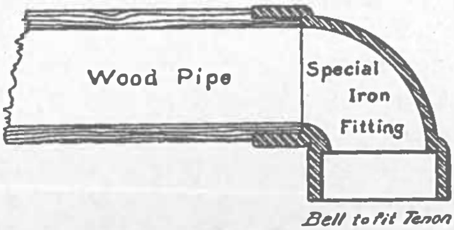


FIG. 2.

similar to regular cast iron fittings except that the bells are finished to the same dimensions as the chambers of wood pipe of same diameter. This requires a section of wood pipe with tenon on each end as previously described.

On account of the great convenience and universal satisfaction, several manufacturers of Valves, Fire Hydrants, etc., are now furnish-

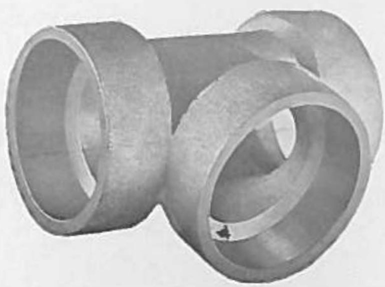


FIG. 3.

PLATE NO. 16.

Laying 28-inch Wood Stave Pipe at Lee, Mass.

ing these accessories chambered in the same manner for direct connection to wood pipe.

Standard flanged fittings may be used with wood pipe by the introduction of our bell and flange connection. This casting is made

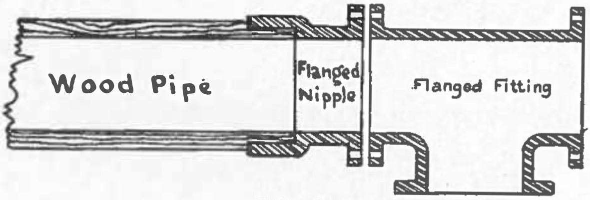


FIG. 4.

with a bell on one end to be driven on to the tenon of the wood pipe. The flange is faced and drilled to standard bolt circle.

Threaded.

Threaded Fittings and connections to threaded wrot pipe are provided for by supplying special sections of wood pipe in which a reamed end of proper diameter is substituted for regular chamber or tenon as the case may require. The male screw on the threaded nipple cuts the female screw in the wood pipe as the junction is made, forming a tight and satisfactory connection. Especially in the smaller sizes this style is very efficient and inexpensive.

Connection Between Wood and Cast Iron.

For connecting our wood pipe to bell and spigot cast iron pipe we furnish a special casting, one end with bell as shown in Fig. 4, which is driven on to the wood tenon. The other end of the connecting piece is cast either standard spigot or bell end.

A Partial List of the Users of Wood-Stave Pipe.

Windber, Pa. .... Windber Water Co.
Norfolk, Va. .... Norfolk County Water Co.
Riley, Me. .... International Paper Co.
Lee, Mass. .... Mountain Mill Paper Co.
Jaffrey, N. H. .... Jaffrey Electric Co.
Houtzdale, Pa. .... Houtzdale Water Co.
Canajoharie, N. Y. .... Water Works.
Swanton, Vt. .... Water Works.

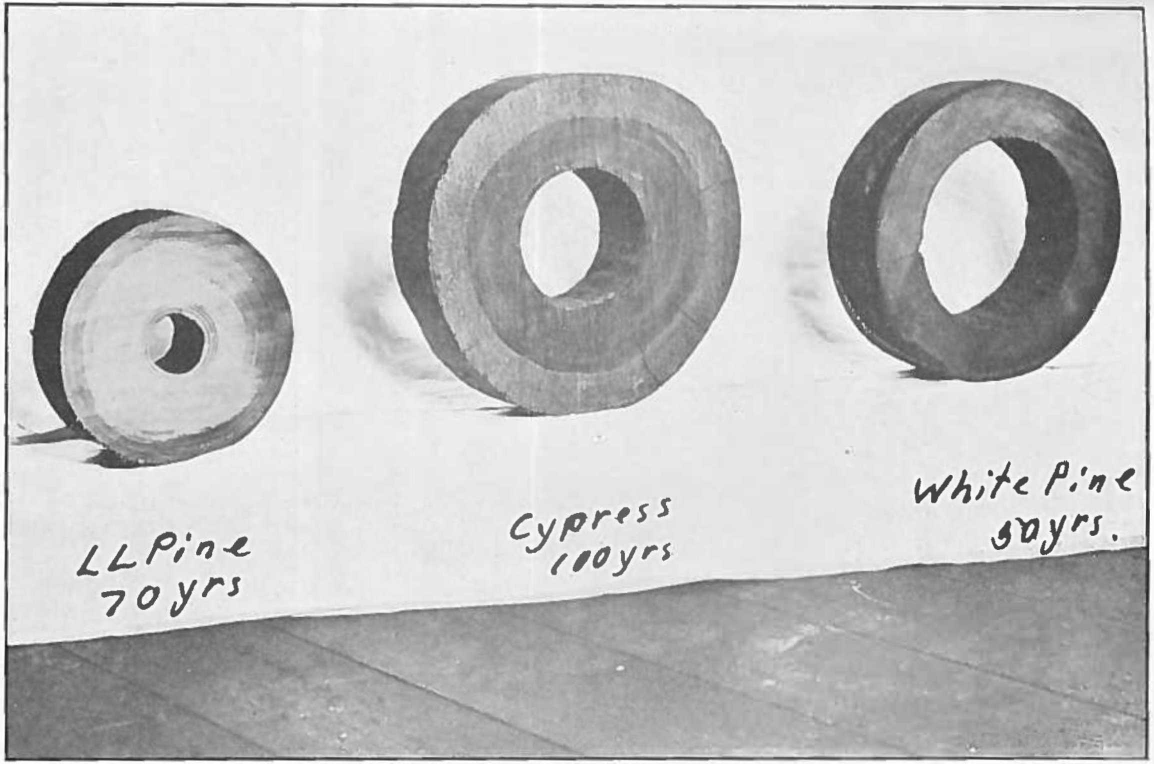


PLATE NO. 17.

Showing Samples of Old Pipe.

Akron, Ohio ....Water Works.
Butler, Pa. ....Water Works.
Elmira, N. Y. ....Water Works.
Holland, N. Y. ....Water Works.
Camden, N. Y. ....Water Works.
Tonawanda, N. Y. ....Water Works.
Syracuse, N. Y. ....Syracuse Salt Co.
Lynchburg, Va. ....Water Works.
Quincy, Ill. ....Water Works.
Swanton, Vt. ....Water Works.
Pittsburg, Pa. ....Pittsburg Coal Co.
Philadelphia, Pa. ....Pocahontas Colleries Co.
Scranton, Pa. ....Mt. Jessup Coal Co.
Carnegie, Pa. ....Carnegie Coal Co.
Glouster, O. ....Sedalia Coal Co.
Pittston, Pa. ....Black Diamond Coal Co.
Baltimore, Md. ....Cumberland Coal Co.
Terra Haute, Ind. ....Indiana Bituminous Coal Co.
Glace Bay, C. B. ....Dominion Coal Co.
Roanoke, Va. ....Buckeye Coal and Coke Co.
Fairmont, W. Va. ....Fairmont Coal Co.
Madisonville, Ky. ....Victoria Coal Co.
New York, N. Y. ....United Verde Copper Co.
New York, N. Y. ....Tennessee Copper Co.
Brazil, Ind. ....Brazil Block Coal Co.
Pueblo, Colo. ....American Smelting & Refining Co.
New York, N. Y. ....Lehigh Valley Coal Co.
Scranton, Pa. ....D., L. & W. R. R. Co.
Scranton, Pa. ....D. & H. Co.
New York, N. Y. ....Erie R. R. Co.
Chicago, Ill. ....Chicago, Milwaukee & St. Paul R. R. Co.
Elkins, W. Va. ....West Virginia Central & Pittsburg Ry. Co.
Rutland, Vt. ....Rutland Railway Co.
St. Louis, Mo. ....Missouri, Kansas & Texas R. R. Co.
Pittsburg, Pa. ....H. C. Frick Coke Co.
Streator, Ill. ....Chicago, Wilmington & Vermilion Coal & Coke Co.
Thomas, W. Va. ....Davis Coal & Coke Co.
Philadelphia, Pa. ....Pennsylvania Coke & Coal Co.
Columbus, O. ....Black Diamond Coal & Coke Co.
Pittsburg, Pa. ....American Coke Co.
New York, N. Y. ....United States Leather Co.

Ashtabula, O.	Ashtabula Hide & Leather Co.
Boston, Mass.	American Hide & Leather Co.
Harrisonburg, Va.	P. J. Houck Tanning Co.
Morrisville, Vt.	Warren Leather Co.
Berlin, Ont.	Breithaupt Leather Co.
Hudson, Mass.	Dunn, Green & Co.
Boston, Mass.	E. Cummings & Co.
Washington, D. C.	U. S. Comm. of Fish & Fisheries.
Chicago, Ill.	Swift & Co.
Cleveland, O.	The Geo. Worthington Co.
Pittsburg, Pa.	American Sewer Pipe Co.
Allentown, Pa.	Allentown Steam Heat & Power Co.
Empire, O.	Miner Fire Brick Co.
York Haven, Pa.	York Haven Paper Co.
Lansing, Mich.	Genesee Fruit Co.
New York, N. Y.	Sulphur Mining Co.
Jackson, O.	Star Furnace Co.

The Wyckoff Wood Pipe has been furnished to all parties appearing in the above list, and the Company invites those interested to communicate with any of the parties here mentioned to ascertain from the actual users the merits or demerits of the wood stave pipe; it is for this purpose that this list is here presented.

Wyckoff

Patent Steam Pipe Casing

Shell 2¼″ Thick

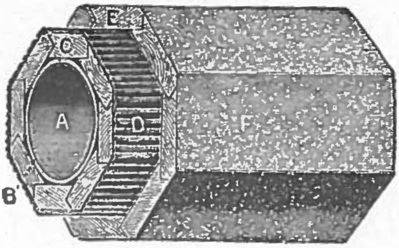


PLATE NO. 18.

A—Tin Lining. B—Asbestos. C—Wood. D—Corrugated Paper. E—Wood. F—Asphaltum Coating.

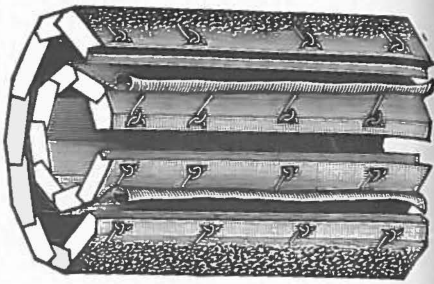


PLATE NO. 20.

Then cut paper on the inside shell, staple and cut wire same as outside. If this Covering is to be cut in halves, remove coating, staple and cut wires at the opposite joint in the same manner.

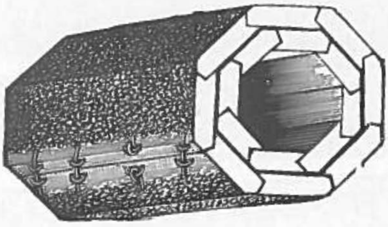


PLATE NO. 19.

This plate shows the manner of preparing the Wyckoff Patent Steam Pipe Covering for cutting lengthwise. Remove the asphaltum coating and staple the wire on each side of joint, as shown in plate. File or cut the wire between the staples. This will allow the outside covering to be opened as shown in Plate 20.

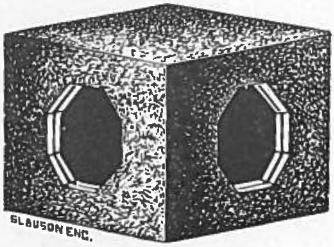


PLATE NO. 21.

Plate 21 illustrates the manner of covering tees and elbows. The top is put on with screws, so that it can be easily and quickly removed whenever necessary.

Wyckoff's Water-Proof Patent Steam Pipe Casing.

For Underground and Exposed Steam Pipes and Hot Water Pipes.

The Wyckoff Patent Casing is constructed of thoroughly seasoned gulf cypress staves, one inch thick.

The staves are closely jointed together, wound with heavy galvanized steel wire, and then wrapped with two layers of heavy corrugated paper.

It is finished by having put on the outside another casing of one inch gulf cypress jointed staves, which is wound with galvanized steel wire, thus making two casings of wood each one inch thick with a perfectly non-conductive lining of corrugated paper between. This makes a combination of non-conductive materials that absolutely prevents the radiation of heat.

Between each layer of wood and paper there is a thin air chamber which adds to the Casing's non-conductive qualities.

For underground use, the Casing is completely coated on the outside with Hydrolene-B. When used overhead, the Casing is furnished painted on the outside with black asphaltum paint.

We make the Casing in lengths of from four to eight feet. The lengths are connected by tenon and socket joints. In putting over the pipe it requires simply to be driven together.

The Wyckoff Patent Casing is so carefully manufactured that a perfect pipe is produced, thoroughly waterproof and will not check open.

It is the most efficient and economical protection made for steam or hot water pipes underground, or for exposed steam pipes, in mine shafts, etc., for long steam lines indoors, for cold storage and brine pipes, and for use anywhere where heat or cold is to be confined.

The Casing is made to slip on over the pipes while they are being connected up. Where the pipes are in place and cannot be disconnected for the purpose of sliding the casing on we furnish the Patent Casing opened as shown in Plates 19 and 20 at a slight additional cost.

For steam pipes conveying high pressure steam, to prevent the wood charring on account of the high temperature of the steam pipes, we line the Patent Casing with tin and two layers of asbestos paper.

Where the tin and asbestos lined Covering is used, no matter how high the steam pressure, no other wrapping or covering for the steam pipes is necessary. The Unlined Patent Covering is for protecting low pressure steam and hot water pipes.

We would be pleased to quote prices for any size or quantity you may need.

It is essential that we know whether any tees, elbows or variators are to be used when we are quoting prices.

In naming size wanted, be sure and make allowances for slipping the Covering over the couplings on the pipe to be covered.

Price List of Boxes to Cover Tees, Ells, Etc.

(For use in conjunction with the Patent Covering and Stave Casing)
Subject to the same discounts as the Casing.

Inside Diameter Cover in Inches	Unlined	Tin and Asbestos Lined
2 inch	$3.20	$4.20
2½ "	3.40	4.40
3 "	3.80	4.80
4 "	4.20	5.20
5 "	4.80	6.00
6 "	5.00	6.20
7 "	5.20	6.40
8 "	5.50	6.70
9 "	5.80	7.20
10 "	6.20	7.70
11 "	6.50	8.00
12 "	7.00	9.00
13 "	7.50	9.50
14 "	8.00	10.50

In the larger sizes, these Boxes are very bulky and cumbersome and especially where there is heavy overhead traffic, we recommend that instead, the fittings be bricked up and packed with mineral wool or some insulating substance of that nature. A manhole in the brick work will give easy access to the fitting and this method will give better results where the pipe is large in size.

In Ordering Casing.

Give size of Casing and size of pipe to be covered.

State whether the lines are in place and cannot be disconnected for slipping the regular Casing over the pipes, or whether the lines are just being connected up.

State whether the pipes convey low pressure steam or hot water, or high pressure steam.

If many elbows and tees are used in the line, send us sketch giving measurements from center to center. We can then furnish the Casing in exact lengths ready to lay without any cutting being necessary on the ground.

Also state whether the line is to be used underground or above

Water-Proof Casings.

We want to call the attention of manufacturers and mine operators, and all concerns that use underground pipes and steam lines running out of doors, exposed to the weather, and in damp mine shafts, conveying steam for power purposes to pumps, steam drills, car hoists, etc., to our Casing.

The Casing is a perfect insulation as well as a thorough protection to the pipes. Ground radiation and condensation in the pipes is practically eliminated with our Casing.

Our Casing can be taken off and replaced without injury.

Weights.

Applying to All 2 inch Shell Casing.

Inside Diameter of Casing	Weights Per Foot
2 inch	6 Pounds
2½ "	7 "
3 "	8 "
4 "	9 "
5 "	11 "
6 "	12 "
7 "	14 "
8 "	15 "
9 "	16 "
10 "	18 "
12½ "	20 "
13 "	22 "
14 "	24 "
15 "	25 "
16 "	27 "
17 "	30 "
19 "	33 "
21 "	36 "

Wyckoff Patent Unlined Casing.

For Hot Water and Low Pressure Steam Pipes.

Price List.

For Use On Steam Lines **NOT** Exceeding 5 Pounds Pressure.

Inside Diameter of Covering	FOR COVERING	Price Per Foot
2 inch	1 inch steam pipe	$0.28
2½ "	1¼ or 1½ " " "	.34
3 "	2 " " "	.40
4 "	2½ " " "	.44
5 "	3 or 3½ " " "	.52
6 "	4 or 4½ " " "	.64
7 "	5 " " "	.76
8 "	6 " " "	.84
9 "	7 " " "	.90
10 "	8 " " "	.98
11 "	9 " " "	1.06
12½ "	10 " " "	1.16
15 "	12 " " "	1.46
17 "	14 " " "	1.70
19 "	16 " " "	1.86
21 "	18 " " "	2.10

Dis.—

Wyckoff Patent Steam Pipe Casing.

Lined with Tin and Asbestos.

Price List.

For Use On Steam Lines Exceeding 5 Pounds Pressure.

Inside Diameter of Covering	FOR COVERING	Price Per Foot
2 inch	1 inch steam pipe	$0.38
2½ "	1¼ or 1½ " " "	.44
3 "	2 " " "	.50
4 "	2½ " " "	.58
5 "	3 or 3½ " " "	.68
6 "	4 or 4½ " " "	.84
7 "	5 " " "	.96
8 "	6 " " "	1.04
9 "	7 " " "	1.12
10 "	8 " " "	1.24
11 "	9 " " "	1.30
12½ "	10 " " "	1.40
15 "	12 " " "	1.70
17 "	14 " " "	2.00
19 "	16 " " "	2.20
21 "	18 " " "	2.60

Dis.—

Contraction and Expansion.

In covering long lines of pipe, we recommend that in each section of Covering a short piece of gas pipe, or a rub iron of some sort be placed, to allow the pipe to roll in contraction and expansion, without tearing the Covering apart.

Sleeves to Cover Flanges.

Where flange joints are to be covered and it is not decided to use Covering for the pipe large enough to take in the flange also, we can furnish sleeves, split lengthwise to go around the flange and fasten down over the adjoining ends of the pipe covering. These sleeves are made in the same way as the Covering itself, and are about 1½ feet long.

Where flanged pipe is used for the steam lines, if the exact measurement between flanges is given us, we can furnish the Covering cut to fit between the flanges.

Introduction.

In calling your attention to our NEW IMPROVED STEAM PIPE CASING it is perhaps appropriate to briefly review the history of our Wyckoff Patent Steam Pipe Casing for underground and exposed steam lines.

Several years ago A. Wyckoff, of Elmira, N. Y., obtained letter patents upon machines for making a sectional Wood Casing to prevent the radiation of heat. This casing, at first only locally used, soon made its merits known and the market rapidly expanded. This increased demand led to the erection and equipment of a testing laboratory in which experiments have been made under the directions of several well known heating engineers, to determine the most durable wood, the proper thickness of the two shells of wood, the proper dead air space between the two shells, make the casing waterproof; the best coating to prevent oxidation of the galvanized steel wire, and many other useful and necessary points to be known before turning out upon the public a finished product.

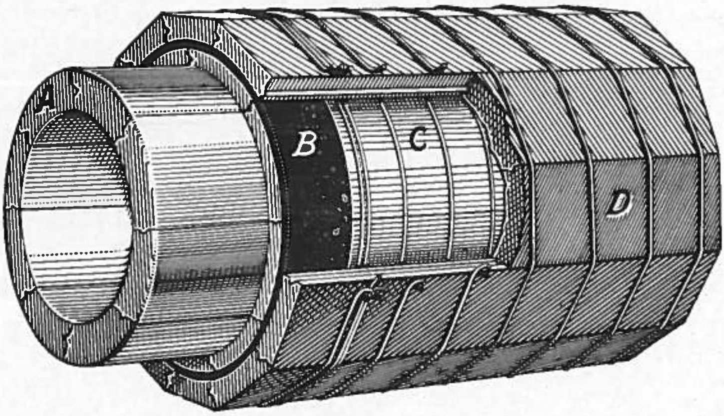


PLATE NO. 22.

A—2 Inch Inner Shell.
B—Asphaltum Packing.
C—¼ Inch Dead Air Space.
D—1 Inch Thick Outer Shell.

The Improvements.

1. Using Gulf Cypress, the Wood Eternal.
2. Doubling the thickness of the inner shell of wood.
3. Increasing the dead air space fifty per cent.

The cut shows the casing before being coated with Hydrolene-B.

Wyckoff's Improved Cypress Steam Pipe Casing.

For Hot Water and Low Pressure Steam Pipes.

Price List.

For Use on Steam Lines NOT Exceeding 5 Pounds Pressure.

Inside Diameter of Casing	For Covering	Price Per Foot
2 inch	1 inch steam pipe	$0.50
2½ "	1¼ or 1½ " " "	.58
3 "	2 " " "	.62
4 "	2½ " " "	.66
5 "	3 or 3½ " " "	.78
6 "	4 or 4½ " " "	.82
7 "	5 " " "	.90
8 "	6 " " "	.98
9 "	7 " " "	1.10
10 "	8 " " "	1.26
11 "	9 " " "	1.40
12½ "	10 " " "	1.58
15 "	12 " " "	1.80
17 "	14 " " "	2.24
19 "	16 " " "	2.74

This Casing CANNOT be opened to apply on pipes already in place. Write for Dis.

Wyckoff's Improved Cypress Steam Pipe Casing.

Lined with Tin for High Pressure.

Price List.

For Use on Steam Lines Exceeding 5 Pounds Pressure.

Inside Diameter of Casing	For Covering	Price Per Foot
2 inch	1 inch steam pipe	$0.58
2½ "	1¼ or 1½ " " "	.68
3 "	2 " " "	.74
4 "	2½ " " "	.80
5 "	3 or 3½ " " "	.92
6 "	4 or 4½ " " "	1.00
7 "	5 " " "	1.10
8 "	6 " " "	1.18
9 "	7 " " "	1.36
10 "	8 " " "	1.58
11 "	9 " " "	1.70
12½ "	10 " " "	1.90
15 "	12 " " "	2.06
17 "	14 " " "	2.74
19 "	16 " steam "	3.30

This Casing CANNOT be opened to apply on pipes already in place. Write for Dis.

The Wyckoff Improved Cypress Casing weighs forty per cent. more than the weight shown on page 47.

Construction of the Wyckoff Improved Cypress Steam Pipe Casing.

Our casing is composed of selected and carefully inspected staves of Gulf Cypress. The 2-inch staves for the inner shell are drawn together by heavy tension into the form of a tube and firmly bound with galvanized steel wire, wound spirally with extra wrappings at each end. This is effected by bending over about one inch of the end of the wire which is driven into the wood about two inches from the end of the casing. The spiral winding is then carried to the end of the casing back over itself and then to the other end of the casing, where it is again wrapped back over itself for about two inches and the final end of the wire securely fastened down by means of staples.

The next operation is placing four layers, four inches wide, of Asphaltum packing on each end of the casing. This material is drawn around the casing as tightly as possible and fastened. It is finished by putting on the outside another casing of one-inch Cypress jointed staves, which is bound with heavy galvanized steel wire, the same as the inner shell, thus making two casings of Cypress wood, the inner shell 2 inches thick and the outer shell 1 inch thick, with a ¼-inch dead air space extending the entire length of the casing, between the shells, except the four inches on each end. This makes the combination of non-conductive materials which absolutely prevents the radiation of heat.

From our experience we have found that Asphaltum packing will absolutely prevent drain water from getting in between the two shell of Cypress.

For underground use the Casing is completely coated on the outside with Hydrolene-B and then rolled in sawdust, the sawdust acting as a binder, to prevent the coating from being scraped off in transit. When used over head, the Casing is furnished painted on the outside with black asphaltum paint.

We make the Casing in lengths of from 4 to 12 feet. The lengths are connected by tenon and socket joint and have to be driven together, thus making a water-tight joint.

The Improved Casing is made to slip on over the pipes while they are being connected up. It CANNOT be opened to apply on pipes already in place.

For pipes conveying steam, where the pressure is more than 5 pounds, to intensify heat radiation, keep a more uniformly high temperature in the line and also more efficiently protect the pipe, we line the Casing with tin.

Where the tin lined Casing is used, no matter how high the steam pressure, the extra thickness of the inner Cypress shell will positively prevent the danger of collapsing.

We would be pleased to quote prices for any size or quantity you may need. In naming size wanted, be sure and make allowance for slipping the Casing over the couplings on the pipe to be covered, also state the approximate steam pressure to be carried.

Cypress, the Wood Eternal.

The new International Encyclopedia says that "The Cypress tree is famous alike for the great age it reaches and for the durability of its wood. The wood is red or yellowish, compact, endurable. It is not subject to attacks of insects. It is believed to be the Cedar Wood of Scriptures and possibly the Gopher also. Museum specimens are known to be several thousand years old, and the old doors of St. Peter at Rome lasted for more than 1100 years, until replaced by doors of bronze."

Dr. Herman Schrenk, our foremost authority on the physics and chemistry of woods, in a lecture before a meeting of Michigan lumbermen, said: "We find the evidence of old Cypress forests when we dig down in the swampy flats at the mouth of many rivers. I place before you to-day a section of log taken from the New Orleans drainage canal, some 18 feet below the present level of the Gulf of Mexico, which is probably more than 10,000 years old."

In July, 1910, a relic of the days of Caesar was dug up on the site of the New London County Hall. This is a wooden boat over fifty feet long and 16 feet beam, and it contained many curious things—fragments of Roman pottery and coins of Tetricus and Gaul and of Caransius and Allectus in Britain, which tend to show that the boat must be more than 1600 years old. It is in excellent condition and will soon be placed on public exhibition.

The Cypress coffin, dated 1803, recently exhumed in New Orleans, the wood of which is as sound as the day it was made; the Cypress head board dated 1770, still standing in a cemetery in Charleston, S. C., and the original Cypress shingles still remaining on the houses on Long Island built in 1756, all bear visible evidence to the fact that Cypress, even where exposed to the rigors of the elements, will endure for a century.

Remarkable and impressive as these records are, they dwindle into insignificance when compared with the relative eternity which Cypress Mummy Cases have endured. In ancient Egypt it was the custom, after bodies were embalmed, to encase them in carved Cypress wood coffins. These have been recently discovered in large numbers, and many have been positively identified as belonging to the time prior to and including the reign of Phoroah of Scriptures, so there is hardly a doubt that the large museums possessing mummies in original cases have on exhibition to-day in a perfect state of preservation Cypress wood coffins which were actually viewed by Moses previous to Exodus.

We are filled with awe when we ponder over the mighty changes wrought since then. Vast empires have risen to power and decayed and been forgotten; maginificent cities have been built and flourished and crumbled into dust; countless millions of people have come and struggled through their moment of activity and gone back to oblivion, and the manners and customs and languages and religions have been written and altered and erased and re-written by the finger of time, till it seems that nothing remains unchanged except the everlasting law of Nature and the fibre of the Cypress Wood.

Appendix

Useful Information.

I cu. ft. of water weight 62.5 lbs. (approximately).

I gallon (U. S.) weight 8.33 lbs.

1 miner's inch = 0.02 cu. ft. per second (California Value).

7.48 gallons = 1 cu. ft.

To find the circumference of circle multiply diameter by 3.1416.

To find the area of a circle, square the diameter and multiply the product by 0.7854.

The circumference of a circle multiplied by 0.282 equals the side of a square of the same area.

The circumference of a circle multiplied by 0.31831 equals the diameter.

The diameter of a circle multiplied by 0.8862 equals the side of a square having an equal area.

The side of a square multiplied by 1.128 equals the diameter of a circle the area of which circle equals the area of square.

Doubling the diameter of a pipe will increase its capacity four times.

Friction of liquids in pipes increases as the square of the velocity.

The quantity of water discharged in cu. ft. per second by any pipe is equal to the area of the cross section of the stream in sq. ft. multiplied by the mean velocity per second.

The velocity of the water flowing in any pipe should not exceed 5 feet per second. If greater than this the size of the pipe should be increased.

The mean pressure of the atmosphere is 14.7 lbs. per square inch, so that with a perfect vacuum it will sustain a volume of mercury 29.9 inches, or a volume of water 33.9 ft. high. Thus theoretically water can be lifted by suction 34 feet but practically only about 25 feet.

To find the pressure of water in pounds per square inch, take 1-3 of the head in feet and add to this 1-10 of the head in feet or multiply the head in feet by 0.434.

To find the head in feet producing a certain pressure in pounds per square inch, multiply the pressure by 2.31.

One inch of rainfall per hour per acre equals one cubic foot per second (approximately).

To obtain the horse power of a stream that is dammed, multiply the

Weight of the water discharged in one minute by the head through which it falls and divide by 33,000.—A good turbine will generate about 75 per cent. of this amount.

The horse power necessary to elevate water to a given height is ascertained by multiplying the weight in pounds of the water elevated per minute, by the height in feet and dividing the product by 33,000. An allowance of 25 per cent. should be made for water friction, etc.

Shrinkage of Timber in Seasoning.

Pitch Pine (South), 18¾ inches to 18¼ inches.
Yellow Pine (North), 18 inches to 17⅞ inches.
Pitch Pine (North), 10x10 inches to 9¾x9¾ inches.
White Pine (American), 12 inches to 11⅞ inches.
Elm, 11 inches to 10¾ inches.
English Oak, 12 inches to 11⅝ inches.
Canada Cedar, 14 inches to 13¼ inches.

Table Showing the Loss of Head Due to the Friction of Water in New Cast Iron Pipe, Riveted Steel Pipe and Wooden Pipe.

This table shows the loss of head due to friction of water flowing through cast iron, riveted steel and wooden pipes under various conditions of velocity and discharge. The table also shows the head necessary to produce the given velocity in the pipe.

The column showing loss of head in cast iron pipes is taken from Weston's table of Friction Losses in Pipes, which was calculated from two formulas of H. Darcy, which reduced to English measures are as follows:

$$h=\left\{0.017379+\frac{0.0015965}{d}+\frac{0.0040723+\frac{0.000020816}{d^2}}{v}\right\}\frac{1}{d}\frac{v^2}{2g}$$

$$\text{and } h=\left\{0.0198920+\frac{0.00166573}{d}\right\}\frac{1}{d}\frac{v^2}{2g}$$

in which h = loss of head due to friction, in feet.
d = the internal diameter of the pipe, in feet.
v = the velocity per second, in feet.
i = length of the pipe in feet.
2g = 64.324.

The first formula was used for velocities of flow less than 0.33 ft. per second, and the second formula which is generally known as

"Darcy's Formula," for velocities of flow including and exceeding 0.33 feet per second.

For the loss of head in steel riveted pipes the well known formula of Ganguillet and Kutter has been used; the value of n being taken as .012 for pipe 24 inches and under in diameter, and n = 0.014 for pipes 30 inches and over in diameter. These values of "n" are the ones that apparently agree best with experiments which have been made and recorded. In a paper by Marx, Wing & Hoskins in Trans. Am. Soc. C. E. Vol. 40 is given a table showing the values of "n" derived from different experiments and an examination of this table will show that the values here assumed agree approximately with those in the table. For pipes under 10 inches in diameter, loss of head in steel riveted is not given in the tables.

For the loss of head in wooden pipe Kutter's formula is also used assuming a value of "n" = .009 for pipes 8 inches and under in diameter and "n" = .010 for pipes 10 inches and over in diameter. These values of "n" apparently agree with the greater number of experiments made on wooden pipe.

The mean internal diameter of the pipe, to which each page of the table refers, is given at the head of each page.

The first column of the table gives the mean velocity in feet per second, of the water flowing in the pipe.

The second column gives the head necessary to produce the velocity in the first column, calculated by the laws of falling bodies, independent of friction, loss of head due to influx, and other retarding causes.

The next three columns give the loss of head per 1000 ft. due to friction in cast iron, steel riveted and wooden pipes when the velocity of flow is the same as in the first column and the discharge is the same as in the last two columns.

The following examples illustrate the way in which information contained in the table may be applied.

EXAMPLE No. 1.

What size of pipe will be required to furnish a district with 10,000,000 gallons of water in 24 hours under 100 ft. head; the point of delivery being located 25,000 feet from the reservoir and its elevation 118.75 ft. below the water line of same?

Answer: The loss of head must not exceed 118.75—100 = 18.75 ft. in 25,000 ft. or $\frac{18.75}{25}$ = .75 ft. in 1,000 ft.

On looking in the tables we find that a 30-inch wooden pipe or 36-inch cast iron or riveted steel pipe would be required, viz: Under 30 inches diameter we find a discharge of 10,224,000 gallons with a loss of head of 0.77 in wood, 1.69 in steel and 1.48 in iron. Interpolating we find that for a loss of head of 0.75 the wood pipe will carry

$$10{,}224{,}000 - \left\{ 10{,}224{,}000 - 9{,}504{,}000 \times \frac{2}{11} \right\} = 10{,}093{,}000 \text{ gallons}$$

and therefore meets the requirements.

The cast iron and steel pipe lie between 30 and 36 inches but since 36 inches is the nearest standard size it would probably be used. By looking under the 36 inches diameter we find that 10,224,000 gallons will be discharged with a loss of head in the cast iron of 0.53 ft., and 0.62 ft. in the steel riveted, and that with the required loss of head, 0.75 ft., cast iron will discharge about 12,100,000 gallons and steel riveted about 11,622,000 gallons.

EXAMPLE No. 2.

What will be the discharge from a reservoir in gallons per minute through a ten inch pipe, 5,200 feet long under a head of 18 feet?

Answer: 1st wooden pipe: The loss of head in 1,000 feet will be $\frac{18}{5.2} = 346$ feet; looking in the table we find that with a loss of head of 3.55 ft. a 10-inch wooden pipe discharges 775 gallons per minute and with a loss of 3.46 feet will discharge

$$775 - \frac{9}{65} \times 75 = 764 \text{ gallons, Ans.}$$

2nd: Steel riveted pipe. Loss head = 3.46 feet per 1,000. In table we see that for a loss of head of 3.65 ft., the nearest to the required loss, a steel riveted pipe discharges 625 gallons per minute, therefore a 10-inch steel pipe discharges with a loss of head of 3.46 ft.

$$625 - \left\{ \frac{19}{80} \times 75 \right\} = 607 \text{ gallons per minute.}$$

3rd: Cast iron pipe. Lost head = 3.46 ft. per 1,000.

In the table we see that for a loss of head of 3.34 ft. the discharge is 700 gallons per minute, therefore for a loss of head of 3.46 ft. the 10-inch cast iron pipe will discharge

$$700 + \left\{ \frac{12}{65} \times 75 \right\} = 714 \text{ gallons per minute.}$$

Therefore a 10-inch pipe 5,200 ft. long under a head of 18 feet discharges as follows:

Wooden, 764 gallons per minute.
Cast iron, 714 gallons per minute.
Riveted steel, 607 gallons per minute.

By an intelligent use of these tables any ordinary problem, relating to the flow of water in pipes may be solved.

Pressure of Water at Different Elevations.

Head in Feet	Pressure Per Sq. Inch	Head in Feet	Pressure Per Sq. Inch	Head in Feet	Pressure Per Sq. Inch
1	0.43	51	22.09	105	45.48
2	0.86	52	22.52	110	47.64
3	1.30	53	22.95	115	49.81
4	1.73	54	23.39	120	51.98
5	2.16	55	23.82	125	54.15
6	2.59	56	24.26	130	56.31
7	3.03	57	24.69	135	58.48
8	3.46	58	25.12	140	60.64
9	3.89	59	25.55	145	62.81
10	4.33	60	25.99	150	64.97
11	4.76	61	26.42	155	67.14
12	5.20	62	26.85	160	69.31
13	5.63	63	27.29	165	71.47
14	6.06	64	27.72	170	73.64
15	6.49	65	28.15	175	75.80
16	6.93	66	28.58	180	77.97
17	7.36	67	29.02	185	80.14
18	7.79	68	29.45	190	82.30
19	8.22	69	29.88	195	84.47
20	8.66	70	30.32	200	86.63
21	9.09	71	30.75	205	88.80
22	9.53	72	31.18	210	90.96
23	9.96	73	31.62	215	93.14
24	10.39	74	32.05	220	95.30
25	10.82	75	32.48	225	97.49
26	11.26	76	32.92	230	99.63
27	11.69	77	33.35	235	101.79
28	12.12	78	33.78	240	103.96
29	12.55	79	34.21	245	106.13
30	12.99	80	34.65	250	108.29
31	13.42	81	35.08	255	110.46
32	13.86	82	35.52	260	112.62
33	14.29	83	35.95	265	114.79
34	14.72	84	36.39	270	116.96
35	15.16	85	36.82	275	119.12
36	15.59	86	37.25	280	121.29
37	16.02	87	37.68	285	123.45
38	16.45	88	38.12	290	125.62
39	16.89	89	38.55	295	127.78
40	17.32	90	38.98	300	129.95
41	17.75	91	39.42	310	134.28
42	18.19	92	39.85	320	138.62
43	18.62	93	40.28	330	142.95
44	19.05	94	40.72	340	147.28
45	19.49	95	41.15	350	151.61
46	19.92	96	41.58	360	155.94
47	20.35	97	42.01	370	160.27
48	20.79	98	42.45	380	164.61
49	21.22	99	42.88	390	168.94
50	21.65	100	43.31	400	173.27

Showing the Loss of Head Due to Friction of Water in New Cast Iron Pipe, Riveted Steel and Wooden Pipe.

Diameter 4 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.26	0.00	0.12		0.093	10	14400
0.51	0.00	0.30		0.298	20	28800
0.77	0.01	0.68		0.599	30	43200
1.02	0.02	1.21		1.010	40	57600
1.28	0.03	1.89		1.60	50	72000
1.53	0.04	2.72		2.29	60	86400
1.79	0.05	3.71		3.12	70	100800
2.04	0.06	4.84		4.07	80	115200
2.30	0.08	6.13		5.17	90	129600
2.55	0.10	7.57		6.35	100	144000
2.81	0.12	9.16		7.71	110	158400
3.06	0.15	10.90		9.12	120	172800
3.32	0.17	12.79		10.75	130	187200
3.57	0.20	14.83		12.62	140	201600
3.83	0.23	17.02		14.35	150	216000
4.09	0.26	19.37		16.30	160	230400
4.34	0.29	21.87		18.81	170	244800
4.60	0.33	24.52		20.65	180	259200

Diameter 6 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet. Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.28	0.00	0.09		0.065	25	36000
0.57	0.00	0.23		0.218	50	72000
0.85	0.01	0.52		0.454	75	108000
1.13	0.02	0.93		0.775	100	144000
1.42	0.03	1.45		1.231	125	180000
1.70	0.04	2.09		1.77	150	216000
1.99	0.06	2.85		2.42	175	252000
2.27	0.08	3.72		3.14	200	288000
2.55	0.10	4.70		3.78	225	324000
2.84	0.12	5.81		4.88	250	360000
3.12	0.15	7.03		5.92	275	396000
3.40	0.18	8.36		7.04	300	432000
3.69	0.21	9.82		8.27	325	468000
3.97	0.24	11.38		9.60	350	504000
4.25	0.28	13.07		10.95	375	540000
4.54	0.32	14.87		12.10	400	576000
4.82	0.36	16.79		14.09	425	612000
5.11	0.41	18.82		15.80	450	648000
5.39	0.45	20.97		17.50	475	684000
5.67	0.50	23.23		19.49	500	720000

Diameter 8 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.16	0.00	0.03		0.015	25	36000
0.32	0.00	0.08		0.060	50	72000
0.48	0.00	0.12		0.013	75	108000
0.64	0.01	0.21		0.208	100	144000
0.80	0.01	0.33		0.31	125	180000
0.96	0.01	0.48		0.427	150	216000
1.12	0.02	0.65		0.57	175	252000
1.28	0.02	0.85		0.73	200	288000
1.44	0.03	1.08		0.91	225	324000
1.60	0.04	1.33		1.12	250	360000
1.76	0.05	1.61		1.37	275	396000
1.91	0.06	1.92		1.62	300	432000
2.07	0.07	2.25		1.90	325	468000
2.23	0.08	2.61		2.00	350	504000
2.39	0.09	2.99		2.52	375	540000
2.55	0.10	3.40		2.87	400	576000
2.71	0.11	3.84		3.24	425	612000
2.87	0.13	4.31		3.62	450	648000
3.03	0.14	4.80		4.05	475	684000
3.19	0.16	5.32		4.50	500	720000
3.35	0.17	5.86		4.94	525	756000
3.51	0.19	6.44		5.42	550	792000
3.67	0.21	7.03		5.92	575	828000
3.83	0.23	7.66		6.45	600	864000
3.99	0.25	8.31		7.00	625	900000
4.15	0.27	8.99		7.58	650	936000
4.31	0.29	9.69		8.20	675	972000
4.47	0.31	10.42		8.80	700	1008000
4.63	0.33	11.18		9.45	725	1044000
4.79	0.36	11.97		10.10	750	1080000
4.95	0.38	12.78		10.80	775	1116000
5.11	0.41	13.61		11.44	800	1152000
5.27	0.43	14.48		12.20	825	1188000
5.43	0.46	15.37		12.95	850	1224000
5.58	0.49	16.29		13.72	875	1260000
5.74	0.51	17.23		14.49	900	1296000
5.90	0.54	18.20		15.30	925	1332000
6.06	0.57	19.20		16.15	950	1368000
6.22	0.60	20.22		17.05	975	1404000
6.38	0.63	21.27		17.95	1000	1440000
6.54	0.67	22.35		18.82	1025	1476000
6.70	0.70	23.45		19.70	1050	1512000
6.86	0.73	24.58		20.65	1075	1548000

Diameter 10 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet — Cast Iron	Riveted Steel	Wooden	Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
0.10	0.00	0.01	0.01	0.003	25	36000
0.41	0.00	0.07	0.10	0.06	100	144000
0.71	0.01	0.21	0.29	0.18	175	252000
1.02	0.02	0.43	0.59	0.37	250	360000
1.33	0.03	0.72	1.00	0.63	325	468000
1.63	0.04	1.09	1.50	0.94	400	576000
1.94	0.06	1.54	2.11	1.33	475	684000
2.25	0.08	2.06	2.85	1.78	550	792000
2.55	0.10	2.66	3.65	2.30	625	900000
2.86	0.13	3.34	4.63	2.90	700	1008000
3.17	0.16	4.09	5.68	3.55	775	1116000
3.47	0.19	4.92	6.80	4.25	850	1224000
3.78	0.22	5.83	8.00	5.05	925	1332000
4.09	0.26	6.82	9.30	5.90	1000	1440000
4.39	0.30	7.88	10.75	6.80	1075	1548000
4.70	0.34	9.01	12.30	7.85	1150	1656000
5.00	0.39	10.23	13.90	8.80	1225	1764000
5.31	0.44	11.52	15.60	10.00	1300	1872000
5.62	0.49	12.88	17.40	11.20	1375	1980000
5.92	0.55	14.33	19.50	12.40	1450	2088000
6.23	0.60	15.85	21.25	13.75	1525	2196000
6.54	0.66	17.45	23.50	15.00	1600	2304000
6.84	0.73	19.12	25.50	16.50	1675	2412000
7.15	0.80	20.87	28.00	18.10	1750	2520000
7.46	0.86	22.70	30.50	19.60	1825	2628000

Diameter 12 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.07	0.00	0.01	0.02	0.00	25	36000
0.43	0.00	0.06	0.08	0.05	150	216000
0.78	0.01	0.20	0.17	0.164	275	396000
1.13	0.02	0.43	0.51	0.34	400	576000
1.49	0.03	0.74	0.93	0.60	525	756000
1.84	0.05	1.14	1.42	0.91	650	936000
2.20	0.08	1.62	2.06	1.30	775	1116000
2.55	0.10	2.19	2.78	1.75	900	1296000
2.91	0.13	2.83	3.60	2.27	1025	1476000
3.26	0.17	3.57	4.50	2.86	1150	1656000
3.62	0.20	4.39	5.55	3.51	1275	1836000
3.97	0.25	5.29	6.65	4.22	1400	2016000
4.33	0.29	6.27	7.92	5.05	1525	2196000
4.68	0.34	7.34	9.21	5.85	1650	2376000
5.04	0.39	8.50	10.65	6.82	1775	2556000
5.39	0.45	9.74	12.19	7.75	1900	2736000
5.74	0.51	11.06	13.75	8.85	2025	2916000
6.10	0.58	12.47	15.50	10.00	2150	3096000
6.45	0.65	13.96	17.35	11.20	2275	3276000
6.81	0.72	15.54	19.30	12.50	2400	3456000
7.16	0.80	17.20	21.25	13.80	2525	3636000
7.52	0.88	18.94	23.60	15.20	2650	3816000
7.87	0.96	20.77	25.75	16.60	2775	3996000
8.23	1.05	22.68	28.20	18.20	2900	4176000
8.58	1.14	24.68	30.75	19.80	3025	4356000

Diameter 16 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.08	0.00	0.01	0.02	0.001	50	72000
0.40	0.00	0.04	0.05	0.04	250	360000
0.72	0.01	0.13	0.145	0.09	450	648000
1.04	0.02	0.27	0.30	0.20	650	936000
1.36	0.03	0.45	0.52	0.33	850	1224000
1.68	0.04	0.69	0.79	0.50	1050	1512000
1.99	0.06	0.98	1.11	0.72	1250	1800000
2.31	0.08	1.32	1.50	0.96	1450	2088000
2.63	0.11	1.71	1.94	1.25	1650	2376000
2.95	0.14	2.15	2.43	1.57	1850	2664000
3.27	0.17	2.64	3.00	1.93	2050	2952000
3.59	0.20	3.18	3.62	2.32	2250	3240000
3.91	0.25	3.77	4.30	2.76	2450	3528000
4.23	0.28	4.41	5.05	3.23	2650	3816000
4.55	0.32	5.10	5.81	3.75	2850	4104000
4.95	0.38	6.03	6.85	4.42	3100	4464000
5.27	0.43	6.84	7.80	5.00	3300	4752000
5.58	0.49	7.69	8.80	5.65	3500	5040000
5.90	0.54	8.59	9.80	6.26	3700	5328000
6.22	0.60	9.55	10.80	7.00	3900	5616000
6.54	0.67	10.55	12.00	7.70	4100	5904000
6.86	0.73	11.61	13.20	8.50	4300	6192000
7.18	0.80	12.71	14.50	9.30	4500	6480000
7.50	0.88	13.87	15.70	10.15	4700	6768000
7.82	0.95	15.07	17.15	11.00	4900	7056000
8.14	1.03	16.33	18.50	11.95	5100	7344000
8.46	1.11	17.63	20.00	12.90	5300	7632000
8.78	1.20	18.99	21.50	13.90	5500	7920000
8.94	1.24	19.69	22.50	14.40	5600	8064000

Diameter 20 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.05	0.00	0.00	0.005	0.00	50	72000
0.36	0.00	0.02	0.03	0.01	350	504000
0.66	0.01	0.09	0.09	0.06	650	936000
0.97	0.01	0.18	0.19	0.12	950	1368000
1.28	0.03	0.32	0.33	0.22	1250	1800000
1.58	0.04	0.49	0.51	0.33	1550	2232000
1.89	0.06	0.70	0.72	0.47	1850	2664000
2.20	0.08	0.94	0.98	0.64	2150	3096000
2.50	0.10	1.22	1.26	0.83	2450	3528000
2.81	0.12	1.54	1.59	1.04	2750	3960000
3.11	0.15	1.89	1.95	1.27	3050	4392000
3.42	0.18	2.28	2.37	1.54	3350	4824000
3.73	0.22	2.71	2.92	1.83	3650	5256000
4.03	0.25	3.17	3.28	2.15	3950	5688000
4.34	0.29	3.67	3.80	2.46	4250	6120000
4.65	0.34	4.21	4.85	2.85	4550	6552000
4.95	0.38	4.78	4.95	3.25	4850	6984000
5.26	0.43	5.39	5.59	3.64	5150	7416000
5.57	0.48	6.04	6.28	4.07	5450	7848000
5.87	0.54	6.72	6.95	4.55	5750	8280000
6.18	0.59	7.44	7.70	5.07	6050	8712000
6.48	0.65	8.19	8.45	5.50	6350	9144000
6.79	0.72	8.99	9.30	6.05	6650	9576000
7.10	0.78	9.81	10.19	6.65	6950	10008000
7.40	0.85	10.68	11.10	7.21	7250	10440000
7.66	0.91	11.43	11.90	7.75	7500	10800000

Diameter 24 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.04	0.00	0.00	0.00	0.00	50	72000
0.25	0.00	0.02	0.02	0.00	350	504000
0.46	0.00	0.03	0.03	0.02	650	936000
0.67	0.01	0.07	0.07	0.04	950	1368000
0.89	0.01	0.13	0.13	0.08	1250	1800000
1.10	0.02	0.20	0.20	0.12	1550	2232000
1.31	0.03	0.28	0.27	0.18	1850	2664000
1.52	0.04	0.37	0.37	0.24	2150	3096000
1.74	0.05	0.49	0.48	0.31	2450	3528000
1.95	0.06	0.61	0.61	0.39	2750	3960000
2.16	0.07	0.75	0.75	0.48	3050	4392000
2.38	0.09	0.91	0.90	0.58	3350	4824000
2.59	0.10	1.08	1.04	0.69	3650	5256000
2.80	0.12	1.26	1.26	0.80	3950	5688000
3.01	0.14	1.46	1.45	0.93	4250	6120000
3.23	0.16	1.68	1.68	1.06	4550	6552000
3.44	0.18	1.91	1.90	1.20	4850	6984000
3.65	0.21	2.15	2.15	1.36	5150	7416000
3.87	0.23	2.41	2.40	1.53	5450	7848000
4.08	0.26	2.68	2.67	1.71	5750	8280000
4.29	0.29	2.97	2.95	1.88	6050	8712000
4.50	0.32	3.27	3.22	2.06	6350	9144000
4.72	0.35	3.58	3.55	2.28	6650	9576000
4.93	0.38	3.91	3.90	2.50	6950	10008000
5.14	0.41	4.26	4.21	2.70	7250	10440000
5.35	0.45	4.62	4.56	2.92	7550	10872000
5.57	0.48	4.99	4.96	3.17	7850	11304000
5.78	0.52	5.38	5.32	3.41	8150	11736000
5.99	0.56	5.78	5.72	3.66	8450	12168000
6.21	0.60	6.20	6.14	3.93	8750	12600000
6.42	0.64	6.64	6.58	4.20	9050	13032000
6.63	0.68	7.08	7.01	4.50	9350	13464000
6.81	0.72	7.47	7.40	4.72	9600	13824000

Diameter 30 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.05	0.00	0.00	0.00	0.00	100	144000
0.27	0.00	0.02	0.01	0.00	600	864000
0.50	0.00	0.03	0.04	0.02	1100	1584000
0.73	0.01	0.07	0.09	0.04	1600	2304000
0.95	0.01	0.12	0.15	0.07	2100	3024000
1.18	0.02	0.18	0.23	0.10	2600	3744000
1.41	0.03	0.25	0.32	0.15	3100	4464000
1.63	0.04	0.34	0.44	0.20	3600	5184000
1.86	0.05	0.44	0.53	0.24	4100	5904000
2.09	0.07	0.56	0.71	0.32	4600	6624000
2.31	0.08	0.69	0.87	0.40	5100	7344000
2.54	0.10	0.83	1.03	0.49	5600	8064000
2.77	0.12	0.98	1.25	0.57	6100	8784000
3.00	0.14	1.15	1.46	0.66	6600	9504000
3.22	0.16	1.33	1.69	0.77	7100	10224000
3.45	0.19	1.52	1.93	0.88	7600	10994000
3.68	0.21	1.73	2.20	1.00	8100	11664000
3.90	0.24	1.95	2.46	1.12	8600	12384000
4.13	0.27	2.18	2.80	1.27	9100	13104000
4.36	0.30	2.43	3.05	1.40	9600	13824000
4.58	0.33	2.69	3.42	1.56	10100	14544000
4.81	0.36	2.96	3.76	1.71	10600	15264000
5.04	0.39	3.25	4.15	1.88	11100	15984000
5.27	0.43	3.54	4.50	2.05	11600	16704000
5.49	0.47	3.86	4.90	2.23	12100	17424000
5.72	0.51	4.18	5.30	2.41	12600	18144000
5.95	0.55	4.52	5.75	2.62	13100	18864000
6.17	0.59	4.87	6.20	2.81	13600	19584000
6.40	0.64	5.24	6.70	3.04	14100	20304000
6.49	0.65	5.39	6.85	3.10	14300	20592000

Diameter 36 Inches.

Mean Velocity of Water in Feet Per Second	Head in Feet Required to Produce This Velocity	Loss of Head in Feet, Due to Friction per 1000 Feet			Discharge in U. S. Gallons per Minute	Discharge in U. S. Gallons per 24 Hours
		Cast Iron	Riveted Steel	Wooden		
0.03	0.00	0.00	0.00	0.00	100	144000
0.19	0.00	0.01	0.00	0.00	600	864000
0.35	0.00	0.01	0.005	0.00	1100	1584000
0.50	0.00	0.03	0.03	0.01	1600	2304000
0.66	0.01	0.05	0.06	0.03	2100	3024000
0.82	0.01	0.07	0.08	0.04	2600	3744000
0.98	0.01	0.10	0.12	0.06	3100	4464000
1.13	0.02	0.14	0.16	0.08	3600	5184000
1.29	0.03	0.18	0.21	0.10	4100	5904000
1.45	0.03	0.22	0.26	0.12	4600	6624000
1.61	0.04	0.27	0.33	0.15	5100	7344000
1.76	0.05	0.33	0.39	0.18	5600	8064000
1.92	0.06	0.39	0.46	0.22	6100	8784000
2.08	0.07	0.46	0.55	0.25	6600	9504000
2.23	0.08	0.53	0.62	0.29	7100	10224000
2.39	0.09	0.61	0.71	0.33	7600	10994000
2.55	0.10	0.69	0.81	0.38	8100	11664000
2.71	0.11	0.78	0.92	0.43	8600	12384000
2.86	0.13	0.87	1.01	0.48	9100	13104000
3.02	0.14	0.97	1.15	0.54	9600	13824000
3.18	0.16	1.07	1.27	0.59	10100	14544000
3.34	0.17	1.18	1.40	0.65	10600	15264000
3.49	0.19	1.30	1.53	0.71	11100	15984000
3.65	0.21	1.42	1.67	0.79	11600	16704000
3.81	0.23	1.54	1.82	0.85	12100	17424000
3.97	0.25	1.67	1.98	0.92	12600	18144000
4.12	0.26	1.81	2.13	0.98	13100	18864000
4.28	0.29	1.95	2.30	1.07	13600	19584000
4.44	0.31	2.09	2.46	1.15	14100	20304000
4.60	0.33	2.24	2.65	1.24	14600	21024000
4.75	0.35	2.40	2.82	1.32	15100	21744000
4.91	0.38	2.56	3.03	1.41	15600	22464000
5.07	0.40	2.73	3.22	1.51	16100	23184000
5.22	0.43	2.90	3.42	1.59	16600	23904000
5.38	0.45	3.08	3.65	1.70	17100	24624000
5.54	0.48	3.26	3.85	1.80	17600	25344000
5.70	0.51	3.45	4.01	1.90	18100	26064000
5.85	0.53	3.64	4.30	2.00	18600	26784000
6.01	0.56	3.84	4.52	2.10	19100	27504000
6.17	0.59	4.04	4.77	2.22	19600	28224000
6.30	0.62	4.21	5.00	2.32	20000	28800000

CAST IRON BELL AND SPIGOT WATER PIPE.

Nominal Inside Diameter. Inches	WATER PIPE Standard Thickness and Weights as Adopted May 25, 1908, by the American Water Works Association												Approx. lbs. of Lead per Joint 2 Inch Wide or Deep	Approx. lbs. of Hemp per Joint	Nominal Inside Diameter. Inches
	Class A 100-foot Head 43 lbs. Pressure			Class B 200-foot Head 86 lbs. Pressure			Class C 300-foot Head 130 lbs. Pressure			Class D 400-foot Head 173 lbs. Pressure					
	Thick-ness Inches	Weight Per Foot	Weight Per Length	Thick-ness Inches	Weight Per Foot	Weight Per Length	Thick-ness Inches	Weight Per Foot	Weight Per Length	Thick-ness Inches	Weight Per Foot	Weight Per Length			
3	.39	14.5	175	.42	16.2	194	.45	17.1	205	.48	18.0	216	6.00	.18	3
4	.42	20.0	240	.45	21.7	260	.48	23.3	280	.52	25.0	300	7.50	.21	4
6	.44	30.8	370	.48	33.3	400	.51	35.8	430	.55	38.3	460	10.25	.31	6
8	.46	42.9	515	.51	47.5	570	.56	52.1	625	.60	55.8	670	13.25	.44	8
10	.50	57.1	685	.57	63.8	765	.62	70.8	850	.68	76.7	920	16.00	.53	10
12	.54	72.5	870	.62	82.1	985	.68	91.7	1100	.75	100.0	1200	19.00	.61	12
14	.57	89.6	1075	.66	102.5	1230	.74	116.7	1400	.82	129.2	1550	22.00	.81	14
16	.60	108.3	1300	.70	125.0	1500	.80	143.8	1725	.89	158.3	1900	30.00	.94	16
18	.64	129.2	1550	.75	150.0	1800	.87	175.0	2100	.96	191.7	2300	33.80	1.00	18
20	.67	150.0	1800	.80	175.0	2100	.92	208.3	2500	1.03	229.2	2750	37.00	1.25	20
24	.76	204.2	2450	.89	233.3	2800	1.04	279.2	3350	1.16	306.7	3680	44.00	1.50	24
30	.88	291.7	3500	1.03	333.3	4000	1.20	400.0	4800	1.37	450.0	5400	54.25	2.06	30
36	.99	391.7	4700	1.15	454.2	5450	1.36	545.8	6550	1.58	625.0	7500	64.75	3.00	36
42	1.10	512.5	6150	1.28	591.7	7100	1.54	716.7	8600	1.78	825.0	9900	75.25	3.62	42
48	1.26	666.7	8000	1.42	750.0	9000	1.71	908.3	10900	1.96	1050.0	12600	85.50	4.37	48
54	1.35	800.0	9600	1.55	933.3	11200	1.90	1141.7	13700	2.23	1341.7	16100	97.60	6.25	54
60	1.39	916.7	11000	1.67	1104.2	13250	2.00	1341.7	16100	2.38	1583.3	19000	108.30	8.25	60
72	1.62	1283.4	15400	1.95	1545.8	18550	2.39	1904.2	22850	....	......	.....	128.00	12.50	72
84	1.72	1633.4	19600	2.22	2104.2	25250	....	......	.....	....	......	.....	147.00	15.00	84

The above weights are per length to lay 12 feet, including standard sockets, proportionate allowance to be made for variation, 440 lengths per mile laid. For cost of pipe per foot, see page 75.

Useful Information. Friction of Water in Pipes.

Friction loss, in pounds pressure per square inch, for each 100 feet of length in different size **clean iron pipes** discharging given quantities of water per minute. **Less friction 14 per cent. for wood.**

Gallons per Min.	SIZES OF PIPES—INSIDE DIAMETER.														
	¾ in.	1 in.	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	4 in.	6 in.	8 in.	10 in.	12 in.	14 in.	16 in.	18 in.
5	3.3	0.84	0.31	0.12	....	....	....	....	....	....	....	....	....	....	....
10	13.0	3.16	1.05	0.47	0.12	....	....	....	....	....	....	....	....	....	....
15	28.7	6.98	2.38	0.97	....	....	....	....	....	....	....	....	....	....	....
20	50.4	12.3	4.07	1.66	0.42	....	....	....	....	....	....	....	....	....	....
25	78.0	19.0	6.40	2.62	....	0.21	0.10	....	....	....	....	....	....	....	....
30	....	27.5	9.15	3.75	0.91	....	....	....	....	....	....	....	....	....	....
35	....	37.0	12.4	5.05	....	....	....	....	....	....	....	....	....	....	....
40	....	48.0	16.1	6.52	1.60	....	....	....	....	....	....	....	....	....	....
45	....	....	20.2	8.14	....	....	....	....	....	....	....	....	....	....	....
50	....	....	24.9	10.0	2.44	0.81	0.35	0.09	....	....	....	....	....	....	....
75	....	....	56.1	22.4	5.32	1.80	0.74	....	....	....	....	....	....	....	....
100	....	....	....	39.0	9.46	3.20	1.31	0.33	0.05	....	....	....	....	....	....
125	....	....	....	....	14.9	4.89	1.99	....	....	....	....	....	....	....	....
150	....	....	....	....	21.2	7.0	2.85	0.69	0.10	....	....	....	....	....	....
175	....	....	....	....	28.1	9.46	3.85	....	....	....	....	....	....	....	....
200	....	....	....	....	37.5	12.47	5.02	1.22	0.17	....	....	....	....	....	....
250	....	....	....	....	....	19.66	7.76	1.89	0.26	0.07	0.03	0.01	....	....	....
300	....	....	....	....	....	28.06	11.2	2.66	0.37	0.09	0.04	....	....	....	....
350	....	....	....	....	....	....	15.2	3.65	0.50	0.12	0.05	0.02	....	....	....
400	....	....	....	....	....	....	19.8	4.73	0.65	0.16	0.06	....	....	....	....
450	....	....	....	....	....	....	25.0	9.01	0.81	0.20	0.07	0.03	....	....	....
500	....	....	....	....	....	....	30.8	7.43	0.96	0.25	0.09	0.04	0.017	0.009	0.005
750	....	....	....	....	....	....	....	....	2.21	0.53	0.18	0.08	....	....	....
1000	....	....	....	....	....	....	....	....	3.88	0.94	0.32	0.13	0.062	0.036	0.020
1250	....	....	....	....	....	....	....	....	....	1.46	0.49	0.20	....	....	....
1500	....	....	....	....	....	....	....	....	....	2.09	0.70	0.29	0.135	0.071	0.040
1750	....	....	....	....	....	....	....	....	....	....	0.95	0.38	....	....	....
2000	....	....	....	....	....	....	....	....	....	....	1.23	0.49	0.234	0.123	0.071
2250	....	....	....	....	....	....	....	....	....	....	....	0.63	....	....	....
2500	....	....	....	....	....	....	....	....	....	....	....	0.77	0.362	0.188	0.107
3000	....	....	....	....	....	....	....	....	....	....	....	1.11	0.515	0.267	0.150
3500	....	....	....	....	....	....	....	....	....	....	....	....	0.697	0.365	0.204
4000	....	....	....	....	....	....	....	....	....	....	....	....	0.910	0.472	0.263
4500	....	....	....	....	....	....	....	....	....	....	....	....	....	0.593	0.333
5000	....	....	....	....	....	....	....	....	....	....	....	....	....	0.730	0.408
Comparative Discharging Power of Pipes	Vd5	1.	1.75	2.76	5.66	9.88	15.59	32.	88.2	181.	316.2	498.8	733.4	1024.	1375.

Wood Pipe when older loses none of its carrying capacity, while cast iron often loses from 20 per cent. to 40 per cent.

COST IN CENTS PER LINEAL FOOT OF BELL AND SPIGOT CAST IRON PIPE.

Price per Ton	$21.00				$22.00				$23.00				$24.00				$25.00				Price per Ton
Class	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	Class
inch																					inch
3	15.2	17.0	17.9	18.9	15.9	17.8	18.8	19.8	16.7	18.6	19.7	20.7	17.4	19.4	20.5	21.6	18.1	20.2	21.4	22.5	3
4	21.0	22.8	24.5	26.2	22.0	23.9	25.6	27.5	23.0	24.9	26.8	28.8	24.0	26.0	28.0	30.0	25.0	27.1	29.1	31.2	4
6	32.3	35.0	37.6	40.2	33.9	36.7	39.4	42.1	35.4	38.3	41.2	44.0	37.0	40.0	43.0	46.0	38.5	41.6	44.7	47.9	6
8	45.0	49.8	54.7	58.6	47.1	52.2	57.3	61.4	49.3	54.6	59.9	64.1	51.5	57.0	62.5	66.9	53.7	59.4	65.1	69.7	8
10	60.0	67.0	74.3	80.5	62.8	70.2	77.9	84.4	65.6	73.4	81.4	88.2	68.5	76.6	84.9	92.0	71.3	79.8	88.4	95.8	10
12	76.1	86.2	96.3	105	79.8	90.3	101	110	83.4	94.4	106	115	87.6	98.5	110	120	90.6	103	114	125	12
14	94.1	108	122	136	98.6	113	128	142	101	115	130	146	108	123	139	155	112	128	146	161	14
16	114	131	151.	161	119	137	158	164	125	143	165	177	130	150	172	190	136	156	179	198	16
18	136	157	184	201	142	165	192	211	148	173	201	220	155	180	210	230	161	187	218	239	18
20	157	178	218	241	165	182	229	252	173	196	240	263	180	210	250	275	187	219	260	287	20
24	214	245	293	322	225	257	307	337	235	268	321	352	245	280	325	368	255	296	349	383	24
30	306	350	420	473	321	367	440	495	335	383	460	520	350	400	480	546	365	417	500	565	30
36	411	477	573	656	431	500	600	687	450	522	627	718	470	545	655	750	490	568	682	781	36
42	538	621	752	866	564	651	788	907	589	680	824	948	615	710	860	990	641	740	896	1032	42
48	700	787	954	1102	733	825	999	1155	767	862	1044	1207	800	900	1090	1260	833	938	1135	1313	48
60	962	1159	1409	1662	1018	1215	1476	1742	1054	1215	1476	1742	1100	1325	1610	1900	1146	1380	1677	1979	60

Price per Ton	$26.00				$27.00				$28.00				$29.00				$30.00				Price per Ton
Class	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	Class
inch																					inch
3	18.8	21.1	22.2	23.4	19.6	21.9	23.1	24.3	20.3	22.6	23.9	25.2	21.0	23.5	24.8	26.1	21.7	24.3	25.6	27.0	3
4	26.0	28.2	30.2	32.5	27.0	29.3	31.4	33.7	28.0	30.4	32.6	35.0	29.0	31.5	33.8	36.2	30.0	32.5	34.9	37.5	4
6	40.0	43.3	46.5	49.8	41.6	44.9	48.3	51.7	43.1	46.6	50.1	53.6	44.7	48.3	51.9	55.5	46.2	50.0	53.7	57.4	6
8	55.8	61.8	67.7	72.5	57.9	64.1	70.3	75.3	60.0	66.5	72.9	78.1	62.2	68.9	75.5	80.9	64.3	71.2	78.1	83.7	8
10	74.2	82.9	92.0	99.7	77.0	85.9	95.6	103	79.9	88.9	99.1	107	82.8	92.5	103	111	85.6	95.7	106	115	10
12	94.2	107	119	130	97.6	111	124	135	101	115	128	140	104	119	135	145	109	123	137	150	12
14	116	133	152	168	121	138	157	174	125	143	163	181	130	149	169	186	134	154	175	194	14
16	141	162	187	206	146	168	194	214	152	175	201	222	157	181	208	229	162	188	216	237	16
18	168	195	227	249	175	202	236	258	181	210	245	268	187	217	254	278	194	225	262	288	18
20	195	227	271	298	205	236	281	309	215	245	292	321	217	254	302	332	225	262	312	344	20
24	265	303	363	399	276	315	377	414	286	327	391	429	296	338	405	445	306	350	419	460	24
30	379	433	520	585	394	450	540	607	408	467	560	630	423	483	580	652	437	500	600	675	30
36	509	590	709	812	529	613	738	844	548	636	764	875	568	659	791	907	587	681	819	937	36
42	666	769	932	1072	692	799	967	1114	717	828	1003	1155	743	858	1039	1196	719	888	1075	1238	42
48	867	975	1181	1365	900	1012	1226	1437	933	1050	1272	1510	967	1087	1317	1522	1000	1125	1362	1575	48
60	1192	1435	1744	2058	1237	1491	1811	2137	1283	1546	1878	2217	1329	1601	1945	2296	1375	1656	2013	2375	60

Above is for the Pipe only, does not include Lead, Hemp, Excavating, Hauling, Etc.

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